Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band	)	ET Docket No. 02-380

REPLY COMMENTS OF INTEL CORPORATION

January 31, 2005

EXECUTIVE SUMMARY

In its Comments, Intel commended the FCC for initiating this rulemaking proceeding which proposes to allow unlicensed devices to operate on unused frequencies in the TV broadcast spectrum. Intel stated that permitting new wireless devices to operate in underutilized portions of the TV broadcast bands would vastly improve spectrum access through more flexible spectrum management, produce substantial public interest benefits, and not cause harmful interference to authorized users. Intel further asserted that expeditious modernization of the FCC's spectrum management system is essential to ensure that the Commission's policies evolve with the consumer-driven evolution of new wireless technologies, devices, and services.

In this Reply, Intel provides further support for allowing new wireless devices to operate in underutilized portions of the TV broadcast bands. In doing so, Intel refutes many of the misleading and incorrect claims made by NAB and MSTV, in their jointly filed Comments, as well as some claims made by other Commenters.

Specifically, Intel asserts the following:

First, there is and will continue to be significant "white space" in the TV broadcast bands. At almost any geographic location, there is typically 36 MHz or more of vacant spectrum within channels 20 to 51. For example, there are 14 vacant channels throughout the highly concentrated Los Angeles area – and many of the occupied channels are analog stations (the operations of which will cease at the end of the DTV transition). Also, the TV broadcast bands facilitate spectrum reuse. Thus, the amount of vacant spectrum available is more than sufficient to accommodate new wireless solutions.

Second, permitting new "personal/portable" wireless devices to share the TV broadcast bands would not cause harmful interference to TV reception. Indeed, the operation of such devices in the TV spectrum would not cause harmful interference to authorized services from out of band emissions. Also, the potential for direct pick-up interference in receiving equipment from new wireless devices in the TV broadcast bands is highly improbable. Moreover, allowing new wireless devices to share the TV broadcast spectrum would not cause harmful interference to cable or satellite TV service.

Third, permitting new "personal/portable" wireless devices to share the TV broadcast bands would not cause harmful interference to TV translator stations and cable headends within the Grade B contour. Also, although they are not entitled to formal protection, TV translator stations and cable headends outside of the Grade B contour are invariably located in high, remote areas where there is a low probability of interference – and they can take precautions to even further decrease that probability.

Fourth, allowing new "personal/portable" wireless devices to share the TV broadcast spectrum would not cause harmful interference to wireless microphones having secondary status. Should these users, however, desire more protection, they can employ certain safeguards (*e.g.*, "sensing"). Also, given the numerous unauthorized wireless microphones using the TV broadcast bands, requiring new wireless devices to "sense" wireless microphones would be unreasonable, as the devices would have no way to determine whether they are detecting a licensed or an unauthorized microphone.

Fifth, the FCC proposed various effective methods for preventing harmful interference to authorized services in the TV broadcast spectrum. In particular, depending on the type of new wireless device being operated, the "control signal"

approach, the "sensing" approach, and the "professional installation/GPS" approach would effectively avoid harmful interference to licensed services in the TV broadcast spectrum.

Sixth, the "fluidity" of the DTV transition is not sufficient grounds for precluding the operation of new wireless devices in the TV broadcast bands. Quite to the contrary, permitting such devices to share the TV broadcast spectrum would provide a strong incentive to introduce new, wireless communications devices and systems into the marketplace – including those capable of exploiting synergisms with TV broadcast services. The introduction of such devices would accelerate the DTV transition, thereby benefiting broadcasters, consumers, and TV set manufacturers.

Finally, this proceeding is not a "zero sum game" in which the FCC would "risk" the DTV transition by allowing new wireless devices to operate in the TV broadcast bands. Rather, the broadcast and wireless industries – as well as the public – can and should "win." In fact, the public interest weighs heavily in favor of more flexible spectrum use, as there are tremendous gains to be generated when government enables market forces and consumer demand to determine new technology successes. In particular, permitting new wireless devices to operate in the TV spectrum would lead to the deployment of wireless broadband services in rural and underserved areas.

In sum, Intel strongly supports the Commission's proposal to permit new wireless devices to operate on unused frequencies in the TV broadcast bands. To this end, Intel recommends that the FCC expeditiously modify its Part 15 rules to allow use of the TV broadcast spectrum by such devices. At a minimum, the rule changes should enable wireless broadband operation in underutilized portions of the TV broadcast bands.

Table of Contents

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I. INTRODUCTION

Intel Corporation ("Intel") hereby submits the following reply comments in response to the *Notice of Proposed Rulemaking* released in the above-referenced proceeding of the Federal Communications Commission ("FCC" or "Commission").[1] Intel is the world's largest semiconductor manufacturer and a leader in technical innovation. Intel is also a leading manufacturer of communications and networking chips and equipment.

In its Comments, Intel commended the FCC for initiating this rulemaking proceeding which proposes to allow unlicensed radio transmitters to operate on unused frequencies in the TV broadcast spectrum. Intel stated that permitting new wireless

[1] *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* Notice of Proposed Rulemaking, ET Docket Nos. 04-186, 02-380, rel. May 25, 2004 ("*Vacant TV Channels NPRM*").

devices to operate in underutilized portions of the TV broadcast bands would vastly improve spectrum access through more flexible spectrum management, produce substantial public interest benefits, and not cause harmful interference to authorized users.[2] Intel further asserted that expeditious modernization of the FCC's spectrum management system is essential "to ensure that the Commission's policies evolve with the consumer-driven evolution of new wireless technologies, devices, and services."[3]

In this Reply, Intel provides additional support for allowing new wireless devices to operate in underutilized portions of the TV broadcast bands. In doing so, Intel refutes many of the misleading and incorrect claims made by National Association of Broadcasters ("NAB") and the Association for Maximum Service Television ("MSTV"), in their jointly filed Comments, as well as some claims made by other Commenters.

Specifically, Intel asserts the following:

- there is and will continue to be significant "white space" in the TV broadcast spectrum;
- allowing new "personal/portable" wireless devices to share the TV broadcast bands would not cause harmful interference to TV reception;
- permitting new "personal/portable" wireless devices to share the TV broadcast spectrum would not cause harmful interference to TV translator stations and cable headends;
- allowing new "personal/portable" wireless devices to share the TV broadcast bands would not cause harmful interference to Part 74 wireless microphones;

[2] *See generally* Comments of Intel Corporation, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004 ("Intel Comments").

[3] *See id.* at 2 (citing Spectrum Policy Task Force Report, ET Docket No. 02-135, Nov. 15, 2002, at 1 ("Spectrum Policy Task Force Report")).

- depending on the type of new wireless device being operated, the "control signal" approach, the "sensing" approach, and the "professional installation/GPS" approach would effectively avoid harmful interference to licensed services in the TV broadcast spectrum;

- the "fluidity" of the DTV transition is not sufficient grounds for precluding the operation of new wireless devices in the TV broadcast bands and, in fact, the introduction of such devices would accelerate the DTV transition; and

- the broadcast and the wireless industries, as well as the public, can and should "win" in this proceeding.

Indeed, Intel strongly supports the Commission's proposal to permit new wireless radio transmitters to operate on unused frequencies in the TV broadcast spectrum.

II. THERE IS AND WILL CONTINUE TO BE SIGNIFCANT "WHITE SPACE" IN THE TV BROADCAST BANDS

As Intel and other Commenters stated, there is significant underutilization, or "white space," in the TV broadcast bands[4] – the amount of which will only increase as analog TV transmission and the associated TV translator stations are phased out.[5] In fact, as Intel demonstrated, at almost any geographic location, there is typically 36 MHz or

[4] *Id.* at 5-7; Comments of Microsoft Corporation, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 7 ("Microsoft Comments"); Comments of the Wi-Fi Alliance, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 3 ("WFA Comments"); Comments of Shared Spectrum Company, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 1 ("Shared Spectrum Comments"); Comments of Adaptrum, Inc., *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, April 17, 2003, at 3. *See also* Spectrum Policy Task Force Report at 14; William Lehr, "Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz," New America Foundation: Spectrum Policy Program, Spectrum Series Issue Brief #16, at 1, 8 (July 2004) ("NAF Brief").

[5] Intel Comments at 5-6.

more of vacant spectrum within the TV broadcast bands covering channels 20 to 51[6] – spectrum that NAB/MSTV incorrectly alleged is fully occupied.[7] (This amount of bandwidth is more than adequate to support the provision of broadband services by at least two WISPs.) Furthermore, because the TV broadcast spectrum is divided into six MHz channels, it facilitates spectrum reuse.[8] Thus, the amount of vacant spectrum available in the TV broadcast bands is more than sufficient to accommodate new wireless solutions.

The amount and location of this vacant spectrum that is appropriate for each new wireless solution will depend on the specific parameters of the service being deployed. Indeed, in the same way that high power TV stations require greater separation than low power TV stations, "fixed/access" devices operating at higher power levels (and transmitting from elevated antennas) require greater separation than "personal/portable" and "fixed/access" devices operating at lower power levels (and transmitting from small, non-elevated antennas). Consequently, the most efficient use for spectrum in some locations will be the operation of maximum power "fixed/access" services, while spectrum in other locations will be best suited for low power "personal/portable" and "fixed/access" solutions.

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[6] *Id.* at 6.

[7] Comments of the National Association of Broadcasters and the Association for Maximum Service Television, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 17-21, Exhibit A at 14-23 ("NAB/MSTV Comments").

[8] The six MHz channels facilitate spectrum reuse because each channel is well-defined (*i.e.,* there are no half or overlapping frequency sets), so if the operator detects a vacant channel, s/he can be assured that the full channel is vacant and thus available for reuse.

For example, as an Intel examination of the overlapping coverage of multiple TV broadcast stations in the San Francisco Bay area illustrates, there are at least six vacant TV channels between channels 20 to 51 (*i.e.*, 36 MHz of usable spectrum) in this highly congested area.[9] A survey of the same area by Adaptrum, Inc. observes that, "on average, [there is] 20 MHz vacant bandwidth in channels 14-20, 80 MHz in channels 21-36 and 38-51, and 70 MHz in channels 52-69."[10] The New America Foundation ("NAF") *et al.* and Shared Spectrum Company cited similar findings in their Comments.[11] Indeed, there is and will continue to be significant "white space" in the TV broadcast bands.

Despite the weight of evidence to the contrary, NAB/MSTV claim that that, "during the DTV transition, there is little or no 'white space' spectrum available outside of unpopulated areas."[12] Some of NAB/MSTV's findings, however, are misleading, as their study is limited to only those channels that would be usable on a non-interfering basis by high power "fixed/access" services operating at maximum permissible power and transmitting from high elevation antennas. In this regard, the NAB/MSTV study clearly shows that, in less densely populated areas (*i.e.*, where "fixed/access" services are most likely to be deployed), there are a significant number of usable channels available.[13] Moreover, extrapolations from the NAB/MSTV study indicate that a significant amount

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[9] Intel Comments at 6.

[10] *Id.* at 6.

[11] *See* Comments of the New America Foundation *et al.*, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 8-9, Appendix A at Secs. 2, 3 ("NAF Comments") (finding that even "the City of Los Angeles [a dense urban environment] contains blocks of contiguous usable channels"); Shared Spectrum Comments at 2, Appendix A at 12-13 (finding that at least 84% of the TV broadcast channels in the congested New York City market are unused).

[12] NAB/MSTV Comments at 17.

[13] *Id.* at Exhibit A at 14-23.

of usable spectrum would be available in all geographic locations for the deployment of low power "personal/portable" and "fixed/access" services.[14]

Specifically, NAB/MSTV's analysis only considers channels available for use by "fixed/access" devices operating at power levels of 4 watts with antenna heights of 30 meters.[15] With these parameters, the interference range to a TV receiver is at least 50 kilometers or so, depending on the terrain.[16] In reality, however, the authorization for "fixed/access" devices is based on protecting stations from harmful interference within their service contours[17] – it is *not* based on a fixed output power, as NAB/MSTV indicate in their analysis. Indeed, in practice, operators are free to (and often do) operate "fixed/access" transmitters at power levels much less than the maximum permitted pursuant to the protection criteria. This reality significantly increases the amount of "white space" available for "fixed/access" devices – even in allegedly congested areas.[18] Moreover, even in the absence of Transmitter Power Control, the maximum interference protection range required for the operation of new wireless "personal/portable" devices is

[14] This conclusion is based on the application of the correct interference protection range to the analysis provided by NAB/MSTV. *See id.* at Exhibit A at 17-22 (Figures 6-11). As Intel explains, the maximum interference protection range required for the operation of "personal/portable" devices is 8 kilometers, resulting in exclusion ranges far less than those of high power "fixed/access" services. *Infra* Section II. at 6-7.

[15] NAB/MSTV Comments at Exhibit A at 14.

[16] Intel calculated this interference range based on the parameters set forth in the NPRM. *Vacant TV Channels NPRM* at 29 (Appendix B: Proposed Rules).

[17] *Id.* at 14-17. Intel notes that this calculation calls for the "appropriate maximum power of the device and the actual antenna height with a minimum of 10 meters – not the maximum permissible power of the device or the 30 meter antenna height (as NAB/MSTV improperly use). *Id.* at 16-17 n.50.

[18] *See, e.g.*, Intel Comments at 14, Appendix B at 2 (discussing the operation of devices at 100 mW). Indeed, wireless devices operating at 100 mW are able to do so on a non-interfering basis in many more locations than those cited by NAB/MSTV.

8 kilometers,[19] resulting in exclusion ranges far less than those of high power "fixed/access" services.

Applying the transmitter power parameters for low power "personal/portable" and "fixed/access" devices (as set forth by the FCC)[20] to these low power services, Intel conducted a study of the channels available in the Los Angeles area in December 2004.[21] We selected this area because the FCC's TV database indicates that it has the highest concentration of TV broadcast stations in the country (*i.e.*, 40 analog, 34 digital, and 38 TV translator stations within a radius of 130 kilometers around central Los Angeles). Intel found that the stations within this area could be divided into two categories based on their coverage:

(i) stations that provide almost total coverage of the area south-southwest of the San Bernardino mountains; and

(ii) stations that provide primary coverage northeast of the San Bernardino mountains.

A Longely-Rice analysis of the heavily populated area south-southwest of the San Bernardino mountains yields similar results to those obtained by examining the Grade B coverage of the stations in this area.[22] Intel found a total of 14 vacant channels (VHF + UHF) throughout this entire area.[23]

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[19] *Id.* at Appendix A at 6.

[20] *Vacant TV Channels NPRM* at 14-17.

[21] *See generally* Channel Availability Analysis – Los Angeles Metropolitan Area, Dec. 2004 (attached as Appendix A) ("Appendix A").

[22] The Grade B coverage area of each station was based on that station's license application (as listed in the FCC's database on Jan. 1, 2005).

[23] *See infra* Section II. at 8 (Table 1: Summary of Vacant TV Broadcast Channels). Intel's analysis takes into account all stations in the area for which a license application had been filed as of January 1, 2005, including those stations under construction.

Table 1. Summary of Vacant TV Broadcast Channels

	Number of Vacant Channels
VHF (Channels 2-13)	5
UHF (Channels 14-51)	9
TOTAL UHF + VHF	14

Intel's study of the Los Angeles area shows that even channel 21, which is assigned within the greater Los Angeles area, is vacant within its primary coverage area south-southwest of the San Bernardino mountains.[24] Intel's study also illustrates that channels used by LPTV stations within channel 21's primary coverage area allow for significant "white space" both inside and outside of channel 21's primary coverage area.[25] Intel further observes that many of the stations currently operating in the Los Angeles area are full service analog stations, analog TV translators, or LPTV analog stations – the operations of which will cease at the completion of the DTV transition – thereby creating even more "white space" in the Los Angeles area.

Moreover, Intel believes that similar analyses conducted by Adaptrum, Inc., the NAF *et al.*, and Shared Spectrum Company also demonstrate the significant amount of "white space" in the TV broadcast spectrum – spectrum which the Commission can and should make available for use by new wireless devices. For example, the analyses show that there are more vacant channels in the TV broadcast bands than there are channels used for the widely successful 802.11b and 802.11g WiFi systems (*i.e.*, three orthogonal channels). If 802.11b and 802.11g can succeed with only three orthogonal channels, it is

[24] Appendix A at 10 (Figure A5).

[25] Appendix A at 11 (Figure A6).

reasonable to suggest that a system with access to six or more channels (as would be the case for most systems) can do at least as well – especially where such a system is able to operate at a greater range.[26]

Of course, new Commission rules should not be predicated upon the current number of vacant channels available in any specific geographic region. Rather, the FCC rules that are adopted as a result of this proceeding should provide a general set of interference guidelines for new wireless Part 15 devices operating in the TV broadcast spectrum – today and tomorrow. In this regard, Intel encourages the Commission to develop flexible rules that can apply to today's technologies and accommodate future, thus-far-unknown technologies.

III. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD NOT CAUSE HARMFUL INTERFERENCE TO TV RECEPTION

This section addresses some Commenters' concerns that new wireless devices would cause harmful interference to TV reception. Specifically, this section explains that (i) permitting new wireless devices to share the TV broadcast bands would not cause harmful interference to authorized services from out of band emissions; (ii) the potential for direct pick-up interference in receiving equipment from new wireless devices operating in the TV broadcast spectrum is highly improbable; and (iii) allowing new wireless devices to share the TV broadcast bands would not cause harmful interference to

[26] *See infra* Section VIII. C. at 43 (discussing the unique propagation characteristics of the TV broadcast spectrum). As the number of vacant channels increases, the separation distances between cells using the same frequency increases. This frequency reuse scenario allows the use of higher order and higher throughput modulation schemes, while maintaining the critical signal to interference ratio required for reliable operation. Therefore, wireless device operators can take advantage of the superior propagation characteristics of the UHF spectrum, as compared to the bands currently used for 802.11(x) (WiFi) operation.

cable or satellite television service. In short, low power "personal/portable" devices – although often operated in close proximity to TV receivers within the home – do not and would not create harmful interference to TV reception.

This section does not discuss the potential of harmful interference to TV reception by high power "fixed/access" devices because these devices would not create any such concerns. Not only is their location fixed/known, but also they can be operated in a way that would preclude any harmful interference to TV receivers (via frequency coordination, professional installation, and output power control).

A. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST BANDS WOULD NOT CAUSE HARMFUL INTERFERENCE TO AUTHORIZED SERVICES FROM OUT OF BAND EMISSIONS

NAB/MSTV assert that the Commission's proposal requiring new wireless Part 15.244 devices to comply with Part 15.209(a) emissions limits[27] outside of the TV channel(s) in which the device is operating would "cause both analog and digital television sets to go blank on all channels of the receiver when such devices are operated indoors."[28] This assertion is without merit.[29]

Indeed, NAB/MSTV's out of band emissions study – on which they base their assertion – incorrectly assumes that: (i) Part 15 devices emit the maximum power allowed under Part 15.209(a), across all frequencies outside of their channel of operation,

[27] 47 C.F.R. § 15.209(a).

[28] NAB/MSTV Comments at 8. Intel notes that NAB/MSTV also fail to address Intel's proposed method for limiting out of band emissions and the use of radiated power control.

[29] In fact, it is Intel's view that NAB/MSTV's out of band emissions study does no more than demonstrate the obvious fact that an interfering signal injected at a level in excess of the interference threshold does indeed cause interference. In this case, NAB/MSTV show that an interfering signal injected at a level permissible under Part 15.209(a) (*i.e.*, 46 dBu) exceeds the interference threshold applicable to a DTV receiver (*i.e.*, 44 dBu – 15 dB = 29 dBu). *Id.* at 10, Exhibit A at 10.

all of the time;[30] (ii) TV viewers in marginal signal strength locations typically attempt to receive programming via indoor antennae;[31] and (iii) the subject TV viewers and their neighbors do not already operate electronic devices covered by Part 15.209(a), which would cause the same type of supposed harmful interference.[32] All of these assumptions are misleading.

In reality, because radiated emissions outside the channel of operation are unintended and unwanted emissions, Part 15 devices are not designed to maximize their emissions level. In fact, quite the opposite is true; at most frequencies, the actual radiated level emitted by a Part 15 device will be far below the permitted maximum.[33] Moreover, only 18.9 percent of homes rely solely upon an over-the-air TV broadcast signal.[34] The majority of these over-the-air viewers live in areas of strong signal strength (where the received signal handily overcomes radiated emissions from other household electronics).[35] The remainder of over-the-air viewers – those located in areas of marginal signal strength – receive their signal using an individual- or MATV-based antenna system, which is far removed from the Part 15 devices in question (and thus is less likely

[30] *Id.* at 8.

[31] *Id.* at Exhibit A at 9.

[32] *Id.* at Exhibit A at 8.

[33] Digital devices typically emit out-of-band emissions in the form of narrow-band multiples of internal clock frequencies, rather than wide-band noise. These narrow-band "spikes" are limited at the Part 15.209(a) levels, and unwanted emissions over most of the spectrum occur at far lower levels.

[34] 81.1% of homes in the U.S. rely on *non*-over-the-air TV reception. *See id.* at 10 (stating that "18.9% of homes in the United States rely solely on over-the-air reception").

[35] Of the 18.9% of homes that rely solely on over-the-air reception, 68.3% reside in the two most heavily populated and highly urbanized categories of counties (*i.e.*, likely to be within the Grade A contour) where the over-the-air broadcast signal is strong. *Home Technology Monitor* Survey, Knowledge Networks/SRI, Spring 2004, at 8 (available at http://nab.org/newsroom/pressrel/filings/ otaatt81104.pdf).

to be susceptible to harmful interference). Further, tens of millions of TV viewers and their neighbors operate electronic devices covered by Part 15.209(a), which would cause the same type of supposed harmful interference to TV receivers as the Part 15 devices in question – and, yet, such interference has not been an issue.[36]

For example, numerous Part 15 Subpart C intentional radiators commonly found in the average American home, such as cordless telephones, WiFi cards, and Bluetooth solutions, are subject to the Part 15.209(a) levels for unwanted emissions in the TV broadcast bands.[37] Operation of these Part 15 Subpart C devices has proven to be compatible with TV viewing in tens of millions of American homes for years.

Moreover, Part 15.231 devices operating in the TV broadcast bands, such as common door openers and remote controls, are permitted far higher emissions levels than those allowed under Part 15.209(a).[38] These devices are authorized under Part 15.231 to emit levels up to 36 dB higher than those permitted under Part 15.209(a) on the channels on which they are operating and up to 16 dB higher on other channels.[39] Even with these increased emissions levels, the operation of door openers, remote controls, and other Part 15.231 devices does not cause harmful interference to TV reception or cause TV receivers to "go blank."

The radiated emissions limits set forth in Part 15.209(a) also apply to ubiquitous Part 15 Subpart B Class B digital devices operating in the TV broadcast bands, such as

[36] Intel notes that this statement also holds true for the multitude of more sensitive Part 15 receivers used in business and law enforcement, which result in few, if any, reports of harmful interference.

[37] 47 C.F.R. § 15.209(c).

[38] 47 C.F.R. § 15.231.

[39] *Id.*

personal computers and electronic toys, and many other electronic devices in the typical American home.[40] Operation of these Part 15 devices does not interfere with TV viewing. Furthermore, the limits for Part 15.3(h) Class A digital devices, as would be found in the office-type environment simulated in the NAB/MSTV study, have emissions levels that are more than 10 dB higher than the level for Class B digital devices (and thus 10 dB higher than the levels authorized under Part 15.209(a)).[41] Even in this type of environment where Class A devices may be present, both over-the-air and cable- and VCR-connected television receivers operate successfully.

B. THE POTENTIAL FOR DIRECT PICK-UP INTERFERENCE IN RECEIVING EQUIPMENT FROM NEW WIRELESS DEVICES OPERATING IN THE TV BROADCAST SPECTRUM IS HIGHLY IMPROBABLE

The Consumer Electronics Association ("CEA") claims that the FCC improperly "overlooked … [t]he potential for interference due to direct pick-up ["DPU"] in cable television viewing receiving equipment."[42] Intel does not believe that the Commission "overlooked" the potential for direct pick-up interference, but rather that the FCC recognized that such interference simply is not relevant to the operation of "personal/portable" devices.

Indeed, the Part 15.118(c)(3) immunity level was developed to minimize the effect of interference to cable television ("CATV") viewing from TV broadcast stations, as users cannot change the fixed location of licensed high power TV broadcast stations in

[40] *See* 47 C.F.R. § 15.3(i) (defining Part 15 Subpart B Class B digital devices); 47 C.F.R. § 15.109(a) (providing emissions limits for these devices, which in the TV broadcast bands, are equal to § 15.209(a) levels).

[41] 47 C.F.R. § 15.109(b).

[42] Comments of the Consumer Electronics Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 3, 10.

their vicinity.[43] In contrast, operators of "personal/portable" devices can and will reconfigure, relocate, or simply disable their equipment to avoid DPU interference in their CATV receiving equipment. Thus, the Part 15.118(c)(3) immunity level requirements are not necessary with respect to "personal/portable" devices – rather, any potential for interference is in the user's control.

Furthermore, the Part 15.118(c)(3) immunity level was specified more than 20 years ago to accommodate the high susceptibility of some older TV set/receiver designs that were prevalent when the rule was written.[44] So called "hot/cold chassis" designs[45] are inherently more susceptible to DPU interference, as the input connection is partially unshielded.[46] Indeed, the most vulnerable targets for DPU interference are the handful of remaining older TV sets connected to set-top boxes and tuned to channels 3 or 4. The Commission has already explicitly recognized this vulnerability and has excluded these channels from operation by "personal/portable" devices.[47] However, TV set-top boxes and newer TV receivers do not use the "hot/cold chassis" design; rather, they incorporate fully shielded tuners – which render these receivers nearly invulnerable to DPU interference. Thus, interference on the UHF channels on which "personal/portable" devices are most likely to operate is highly improbable.

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[43] 47 C.F.R. Part 15.118(c)(3); Delbert H. Heller, "Direct Pick-up Interference in Television Receivers and VCRs Connected to Cable," IEEE Transactions on Consumer Electronics, August 1990, at 56.

[44] Heller at 56.

[45] A "hot/cold chassis" design refers to a TV set where the chassis is directly connected to the AC power line, and safety isolation is provided by an insulated enclosure and a transformer-coupled antenna input.

[46] "Measurement of Television Direct Pick-up (DPU) in a GTEM Cell," *IEEE Transactions on Consumer Electronics*, Nov. 1995, at 1012.

[47] *Vacant TV Channels NPRM* at 34.

Industry experience demonstrates the extent of this improbability. Over the past seven years, as DTV stations have commenced operation, approximately 1,200 new high power broadcast TV stations have begun transmitting, essentially simultaneously.[48] The vast majority of these DTV stations transmit their programming in the UHF band[49] – the band envisioned to be most utilized for new wireless "personal/portable" device operation (due to antenna size considerations). Yet, reports of interference to CATV viewing from these new powerful UHF transmitters have been minimal.[50] In fact, there has only been one notable exception to this trend – WBBM-DT in Chicago, which operates on Channel 3 and had to cease high power operation for a limited period of time because most TV viewers in the station's vicinity received their programming via set-top boxes connected to their TV receivers, which were tuned to Channel 3.[51] As noted previously, even this rare instance of DPU interference will not arise as a result of the operation of "personal/portable" devices, as such devices would not operate on channels 3 or 4 or their adjacent channels.

[48] NAB/MSTV Comments at 5.

[49] "DTV Stations in Operation," NAB (providing list of on-air DTV stations) (available at http://www.nab.org/Newsroom/issues/digitaltv/DTVStations.asp).

[50] Such transmitters, which are capable of transmitting EIRP up to 1 megawatt, produce a field strength exceeding the Part 15.118 limits out to a distance of 15-20 kilometers, encompassing a large number of CATV viewers in most locations. 47 C.F.R. §15.118.

[51] "When WBBM[-DT] started operating from the new permanent DTV antenna, we learned we were causing interference to many Comcast Cable subscribers. WBBM was operating in accordance with FCC rules but decided to return DTV operations to the old antenna. This will give Comcast time to modify their cable systems. We expect to return to operations to our new broadcast antenna later this summer." "Mark's Monday Memo," Digital TV Magazine, July 15, 2003 (citing Bob Ross, Vice President of Operations, CBS) (available at http://www.digitaltelevision.com/mondaymemo/mlist/msg02028.html). This situation illustrates the ability of market forces to rectify an interference situation.

C. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST BANDS WOULD NOT CAUSE HARMFUL INTERFERENCE TO CABLE OR SATELLITE TELEVISION SERVICE

NAB/MSTV assert that the operation of new wireless "personal/portable" devices in the TV broadcast bands will "interfere with viewership of cable and satellite television."[52] (The sole basis for their claim is an incomplete study on cable television ("CATV") signal ingress prepared for NAB and MSTV in this proceeding.[53]) This assertion simply is not true.

NAB/MSTV state that operation of new wireless Part 15.244 "personal/portable" devices in the TV broadcast spectrum would cause harmful interference to CATV systems.[54] Specifically, NAB/MSTV claim that indoor operation of "personal/portable" devices at 400 milliwatts "will prevent consumers in the average American home from watching television on any channel – whether over-the-air or on cable."[55]

As NAB/MSTV study itself notes, when the CATV signal is terminated at both ends, there is no interference to CATV operation using RG-6 cable for distribution throughout the home. Interfering signal ingress was observed only when one end of the cable was not terminated (*i.e.*, unconnected) – an unrealistic scenario. In reality, both ends of a cable are connected, and thus terminated, when a cable is used to deliver a signal to a TV receiver. Accordingly, there is no harmful signal ingress.

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[52] NAB/MSTV Comments at 9.

[53] *Id.* at Exhibit A at 39-40 (Appendix 1). Intel contends that the NAB/MSTV study is incomplete, as it fails to address the signal levels applicable to CATV reception and the frequency ranges applicable to satellite TV reception. Thus, Intel believes that it is impossible to draw conclusions as to whether signal ingress on to the interconnecting cable would actually cause harmful interference.

[54] *Id.* at 9-10.

[55] *Id.* at 7.

Of course, there may be circumstances where a house has multiple CATV outlets in several rooms and some of the outlets are not used. In these cases, where the cable configuration is more complex than the simple example tested in the NAB/MSTV study, some cable outlets may be unused. Typically, however, unused outlets are terminated with screw-in terminators.[56] Even where unused outlets are not terminated in this manner and signal ingress occurs to the unused outlets, such ingress will not cause harmful interference to the used outlets (*i.e.*, those that are connected to TV receivers) because of the high degree of isolation between outputs. Indeed, most multiple outlets are connected to a CATV feed via directional couplers. These couplers have a high degree of isolation between their "tap" and "output" connections (usually 35 dB).[57] Moreover, even where simple hybrid signal splitters are used to connect multiple outlets to a CATV feed, the splitters exhibit high isolation between outputs (usually 23 dB).[58] This high degree of isolation would reduce the ingress signal produced by the configuration in the NAB/MSTV study to a level that the study itself asserts is non-interfering.[59]

In addition, NAB/MSTV observed greater ingress in a sample of some type of RG-59 cable distribution systems. However, RG-59 is not the standard cable used for

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[56] *Residential Telecommunications Infrastructure Standard*, American National Standards Institute/Telecommunications Industry Association, ANSI/TIA-570-B, Sec. 5.3.5.2, April 2004, at 31 ("ANSI/TIA") (stating that "each energized unused coaxial cable shall be terminated with a 75-ohm impedance matching termination device"). *See, e.g.,* Channel Master Model 3218, Channel Master, LLC (available at http//:www.channelmaster.com) (providing an example of a typical terminator).

[57] *See, e.g.,* Channel Master Model 7112A, Channel Master, LLC (available at http//:www.channelmaster.com) (providing an example of a typical directional coupler).

[58] *See, e.g.,* Channel Master Model 7992, Channel Master, LLC (available at http//:www.channelmaster.com) (providing an example of a typical hybrid splitter).

[59] *See* NAB/MSTV Comments at Exhibit A at 40 (Appendix 1) (stating that "RG-6 cable will pick up interference, *if it is not terminated*") (emphasis added). NAB/MSTV state that the ingress level on terminated RG-6 at -68 dBm is "non-interfering." *Id.* at Exhibit A at 40 (Appendix 1).

residential CATV or direct broadcast satellite ("DBS") systems. In NAB/MSTV's own words, RG-6 cable is "the most widely used cable for home installation of cable TV and satellite TV systems."[60] In fact, the American National Standard for residential wiring states that only RG-6 cable should be used for this application.[61] Where consumers use non-standard cabling such as RG-59, they are likely to experience interference from the numerous high power radio transmitters operating in the sub-698 MHz frequencies – including TV broadcasters. This interference alone will cause consumer dissatisfaction and will provide incentive to replace the inadequate RG-59 cable with standard RG-6 cable; the operation of Part 15.244 devices is not a factor in this scenario.

Furthermore, NAB/MSTV incorrectly claim that the antenna used for their cable ingress study had a -5 dB gain and imply that a hypothetical Part 15.244 device with a +6 dB antenna in the same circumstances would generate more ingress,[62] when, in fact, the antenna in question had a +6 to +8 dB gain across the TV broadcast bands.[63] Also, a worse case configuration was employed, whereby the antenna was located extremely close to the coaxial cable (1 meter) and apparently oriented so that its main lobe was aimed directly at the cable.[64] This antenna arrangement is highly unrealistic as such a set-up would hamper proper operation of the new wireless device. Clearly, both the

[60] *Id.* at Exhibit A at 40 (Appendix 1).

[61] ANSI/TIA-570-B at 28 (Sec. 5.3).

[62] NAB/MSTV Comments at 9.

[63] The "Silver Sensor" antenna utilized in the NAB/MSV study, which was developed by Antiference (a U.K. company) and marketed in the U.S. under the Zenith brand, has a +6 to +8 dB gain.

[64] NAB/MSTV Comments at Exhibit A at 30-31, 39 (Appendix 1).

antenna gain and proximity to the coaxial cable were engineered to elicit results that are misleading and fail to imitate actual practice.[65]

Finally, NAB/MSTV claim that operation of new wireless Part 15.244 "personal/portable" devices in the TV broadcast spectrum would cause harmful interference to DBS systems.[66] Not one DBS company raised such a concern in this proceeding – for a very simple and obvious reason. The TV broadcast bands encompass frequencies below 698 MHz. DBS satellite systems, on the other hand, use frequencies in the range of 1 GHz to 2.2 GHz on the downlink cable between the DBS Low Noise Block Converter/Feedhorn ("LNBF") on the dish antenna and the DBS set-top box ("STB"). Therefore, the operation of "personal/portable" devices in the TV broadcast spectrum would have no effect on, much less cause possible ingress to, DBS systems.

IV. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD NOT CAUSE HARMFUL INTERFERENCE TO TV TRANSLATOR STATIONS AND CABLE HEADENDS

As the National Cable & Telecommunications Association ("NCTA") properly states, "[u]nder the FCC's proposed rules, protection from harmful interference will be afforded to [Part 74 Subpart G] receivers [located] within the Grade B contour."[67] This proposed rule is directly in line with current FCC rules, which permit TV translator stations, and thus cable headends, to operate on a secondary basis to full service TV

[65] Intel asserts that "personal/portable" devices should use omnidirectional antennas and, thus, the test methodology used in the NAB/MSTV study is not representative of signal levels in actual implementations.

[66] NAB/MSTV Comments at 9.

[67] Comments of the National Cable & Telecommunications Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 3 ("NCTA Comments").

stations, so long as they meet technical rules to prevent interference to the reception of such TV stations.[68] Current FCC rules further provide that TV translator stations, and thus cable headends' input receivers,[69] are generally protected from interference only within defined signal contours,[70] which for TV translator stations means the Grade B contour of the full service station it is re-broadcasting.[71] Allowing new "personal/portable" wireless devices to operate in the TV broadcast bands would not cause harmful interference to TV translator stations and cable headends located inside the Grade B contour.

In a clear divergence from current FCC rules, the NCTA and the National Translator Association inappropriately ask the Commission to extend protection from harmful interference to cable headends and TV translators located outside of the Grade B contour.[72] Specifically, while NCTA admits that "[local] broadcast signals are generally received at the cable headend [or TV translator] within the Grade B contour defined by the FCC, and therefore are protected under the proposed rules," it states that there are "instances where broadcast signals are received at the cable headend [or TV translator] at locations outside of the Grade B contour."[73] NCTA adds that, "[un]der the proposed

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[68] 47 C.F.R. Part 74 Subpart G; *see also Vacant TV Channels NPRM* at 3 (explaining rules).

[69] Given their similar functions, in this context, the terms "TV translator station" and "cable headend" are used interchangeably.

[70] 47 C.F.R. Part 74 Subpart G; *see also Vacant TV Channels NPRM* at 14 (explaining rules).

[71] 47 C.F.R. Part § 74.707(a)(1); *see also Vacant TV Channels NPRM* at 14 n.47 (citing rules).

[72] NCTA Comments at 3; Comments of the National Translator Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 3 ("NTA Comments").

[73] NCTA Comments at 2; *see also* NTA Comments at 3, 6 (claiming that the proposed rules should "protect television reception out to the limits of practical and useful reception" – *i.e.*, beyond the Grade B contour).

rules, unlicensed devices will be able to transmit on channels used for receipt of [these] distant broadcast television signals, therefore increasing the likelihood that there will be interference with a local broadcast signal received from outside the Grade B contour, particularly in rural markets."[74]

NCTA further notes that, "[i]n the case of broadcast television programming, most cable headends [and TV translator stations] receive terrestrial broadcast signals by using tower-mounted high-gain directional terrestrial antennas, subsequently combining them with cable programming for retransmission within the cable system."[75] NTCA claims that, for a distant television station transmitting on a 1,000 foot tower with a transmit power of 316 kilowatts EIRP and at a distance of 65 miles from the cable headend,[76] the calculated carrier to interference ("C/I") ratio (assuming a new wireless "personal/portable" device within one-tenth of a mile of the receive antenna) is approximately 2 dB (during unfaded conditions).[77] Using the same assumptions, NCTA states that a new wireless "fixed/access" device at a distance of one mile from the receive antenna yields a C/I ratio of 5 dB.[78] However, what NCTA does not mention is that cable headends and TV translators outside of the Grade B contour are invariably located at high elevations in remote areas where operation of new wireless "personal/portable" devices is unlikely and hence there is a low probability of interference.

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[74] NCTA Comments at 2.

[75] *Id.* at 2.

[76] Based on the service contours in the FCC's database of TV broadcast stations, where a tower is located 65 miles from the cable headend, the tower typically is *outside* the station's Grade B contour.

[77] NCTA Comments at 2.

[78] *Id.* at 3.

Furthermore, according to Section 73.622 of the FCC's rules, a station's Grade B contour is calculated based on average terrain and is applicable to TV receivers at any location within the Grade B contour.[79] TV translators or cable headends typically are not located at coverage gaps within the Grade B contour – rather they are located in more favorable reception areas. Consequently, TV translators and cable headends within the Grade B contour receive signals well in excess of the level specified for Grade B coverage and are less vulnerable to interference than a TV receiver that is protected by the FCC's proposed rules.[80] (Intel further notes that, as of December 2004, Section 73.625 of the Commission's rules increased the signal level at the Grade B contour to 48 dBu for DTV in the UHF frequency band.)[81]

Moreover, although they are not entitled to formal protection under the FCC's rules – cable headends and TV translator stations located outside of the Grade B contour can take certain precautions and employ particular mitigation techniques, as they always have, to significantly decrease the probability of interference.[82] For example, vulnerable cable headends and TV translators located outside of the Grade B contour could (i)

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[79] 47 C.F.R. § 73.622.

[80] *See Vacant TV Channels NPRM* at 28-30 (Appendix B: Proposed Rules).

[81] 47 C.F.R. § 73.625. The rule provides in pertinent part:

> The DTV transmitter location shall be chosen so that, on the basis of the effective radiated power and antenna height above average terrain employed, the following minimum F(50,90) field strength in dB above one uV/m will be provided over the entire principal community to be served:
>
> Channels 2–6 ..... 35 dBu
> Channels 7–13 ..... 43 dBu
> Channels 14–69 ..... 48 dBu
>
> NOTE TO PARAGRAPH (a)(1): These requirements above do not become effective until December 31, 2004 for commercial television licensees and December 31, 2005 for noncommercial television licensees. Prior to those dates, the following minimum F(50,90) field strength in dB above one uV/m must be provided over the entire principal community to be served:
>
> Channels 2–6 ..... 28 dBu
> Channels 7–13 ..... 36 dBu
> Channels 14–69 ..... 41 dBu

[82] Intel notes that TV translator stations and cable headend inputs outside of the Grade B contour constantly risk interference from Part 74 wireless microphones and new broadcast stations.

receive a signal by alternate means such as microwave; (ii) transmit a low power beacon signal within the antenna beam over which they receive the broadcast signal;[83] and/or (iii) employ geolocation technology in association with a headend/translator database to supplement the sensing technology.

V. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD NOT CAUSE HARMFUL INTERFERENCE TO WIRELESS MICROPHONES

A few Commenters incorrectly assert that the operation of new wireless "personal/portable" devices in the TV broadcast bands would cause harmful interference to wireless microphone services.[84] This assertion is invalid, as it fails to take into account the methods by which wireless microphone operators can (and currently do) avoid interference.

There are three categories of wireless microphone users. First, under Part 15 of the Commission's rules, the general public may operate wireless microphones on an unlicensed basis in bands such as 49.82-49.90 MHz and 88-108 MHz.[85] Because these users do not have licenses, they need not be considered in the present analysis. Second, under Part 90 of the FCC's rules, entities eligible for the "Public Safety Pool" or the "Industrial/Business Pool" may obtain licenses to operate wireless microphones on eight

[83] If the cable headend receiver can "see" the wireless device, then the device can sense the beacon.

[84] *See, e.g.,* Comments of Shure Incorporated, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 9-16 ("Shure Comments"); Comments of Audio-Technica U.S., Inc., *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 6-9.

[85] 47 C.F.R. §§ 15.235, 15.239 .

channels in the 169-172 MHz band.[86] However, such users do not operate in the "core" TV broadcast bands (*i.e.*, channels 2-51) and, therefore, need not be considered in the present analysis.[87] Third, under Part 74 of the Commission's rules, certain eligible entities (*e.g.*, the TV, motion picture, CATV, MDS, MMDS industry) may obtain licenses to operate wireless microphones as "low power auxiliary stations" with secondary status in the TV broadcast bands.[88] These Part 74 wireless microphone users will be considered in the present analysis.

Intel agrees with NAF that Part 74 wireless microphones are unlikely to experience significant interference from new wireless devices.[89] Moreover, as NAF suggests, should they require additional protection, the wireless microphone operators may prohibit the deployment of new wireless devices on certain frequencies in the TV broadcast bands.[90] Intel also notes that, pursuant to the FCC's rules, Part 74 wireless microphones are intended to operate only over distances of up to approximately 100 meters.[91] The entities eligible for wireless microphone licenses under Part 74.801 of the Commission's rules typically have complete control over their operations within this range.[92] And in the very limited circumstances where the licensees may not be able to

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[86] 47 C.F.R. § 90.265(b).

[87] 47 C.F.R. §§ 15.235, 15.239, 90.20, 90.35.

[88] 47 C.F.R. § 74.832(a).

[89] *See* NAF Comments at 13 (citing *Vacant TV Channels NPRM* at 19) (concurring with the Commission's conclusion that the operational characteristics of wireless microphones significantly reduce the likelihood of interference from unlicensed devices).

[90] *Id.* at 15.

[91] *See* 47 C.F.R. § 74.801 (defining low power auxiliary station).

[92] Indeed, even at outdoor events (*e.g.*, stadium sporting events), facilities typically exercise tight control over entrance by the public and the type of equipment allowed into the venue.

exercise this high degree of control (*e.g.*, a temporary in-the-field deployment within the licensee's authorized geographic region), the wireless microphone could readily detect, or "sense," occupied channels – and therefore determine which channels are and are not available for operation.

In fact, certain wireless microphone companies already incorporate such sensing capabilities into their products. For example, Shure Incorporated's ("Shure") ULX Professional Systems product line boasts "Automatic Frequency Selection" technology – the ability to detect (*i.e.*, "sense") open channels and thus avoid interfering with the operation of other wireless microphones; Shure's ULX Wireless System Specification Sheet states that such technology "provides a straight shot to a clear channel."[93] Accordingly, based on Shure's own declarations, sensing technology is not only feasible, but it is in use today.[94]

In addition, there is substantial evidence that numerous entities and individuals who have not obtained the required Part 74 license and, in many circumstances, are not even eligible for such a license, are operating wireless microphones in the TV broadcast bands.[95] In this regard, Intel notes that Part 74 wireless microphones are readily available

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[93] *See* Shure Incorporated, ULX Wireless System Specification Sheet (2002), at 1 (stating that "Automatic Frequency Selection provides a straight shot to a clear channel") (available at http://www.shure.com/pdf/specsheets/spec_wireless/ulx-specsheet.pdf); Shure Incorporated, ULX Wireless System User Guide (2004), at 7 (describing "Automatic Frequency Selection" technology) (available at http://www.shure.com/pdf/userguides/guides_wireless/ulx_wireless_en.pdf).

[94] Such a declaration also implies that Shure is not concerned about the intermittent operation of other wireless microphones or the operation of wireless microphones in the adjacent TV channels' coverage area, as the company's Comments would lead the Commission to believe.

[95] The widespread unauthorized use of wireless microphones has been brought to the FCC's attention in prior proceedings. *See* Comments of the Society of Broadcast Engineers, Inc., *Reallocation and Service Rules for the 698–746 MHz Spectrum Band (Television Channels 52-59)*, GT Docket No. 01-74, May 14, 2001, at 4 ("SBE suggests that the Commission … use this proceeding to find a home for the many unlicensed, and illegal, wireless microphones used by churches, theaters, conventions, conference centers, and the like, in the mistaken belief that these devices do not require an FCC license. Many times these

by mail order and online[96] – including frequency-agile devices (which have operating frequencies that are under the sole control of the end user).[97] Moreover, it appears that the wireless microphone community provides little information to end users on FCC licensing requirements and tends to greatly minimize the importance of such requirements. For example, in the technical support section of Shure's web site, in response to the question "Where can I read more about an FCC wireless mic[rophone] license?,"[98] customers are directed to another web site, which states the following:

> Q: What will happen to me if I use my wireless mic without a license?
>
> A: Probably nothing. The FCC doesn't appear to be interested in enforcing this requirement.… Most wireless mic[rophone] users are not even aware of the licensing requirement. Many who are view unlicensed operation as being no worse than driving at 5 MPH over the speed limit and choose to 'beg forgiveness rather than ask permission.'"[99]

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users are incorrectly told by vendors that no FCC license is required, and such non-technical/non-spectrum sophisticated users are accordingly often operating their wireless microphones in good faith, believing the operation to be legal. It is not until an FCC field agent shows up in response to an interference problem does the non-technical user find out the truth (and, to add insult to injury, these users may also find out that they are not eligible for a Part 74 BAS license).").

[96] Examples of online wireless microphone vendors are ProAudio Superstore (available online at http://www.proaudiosuperstore.com); ZZounds (available online at http://www.zzounds.com); Same Day Music (available online at http://www.samedaymusic.com).

[97] Frequency-agile systems are available from a variety of manufacturers, including Audio-Technica, Sennheiser, and Shure.

[98] Shure Incorporated, Knowledge, KBASE, Solution Database, Answer ID 2549 (site visited on Jan. 23, 2005) (available online at http://shure.custhelp.com/cgi-bin/shure.cfg/php/enduser/std_adp.php?p_sid=teEDXhwh&p_lva=&p_faqid=2549&p_created=1017244413&p_sp=cF9ncmlkc29ydD0mcF9yb3dfY250PTEwJnBfc2VhcmNoX3RleHQ9bGljZW5zZSZwX3NlYXJjaF90eXBlPTQmcF9wcm9kX2x2bDE9fmFueX4mcF9wcm9kX2x2bDI9fmFueX4mcF9jYXRfbHZsMT1_YW55fiZwX3NvcnRfYnk9ZGZsdCZwX3BhZ2U9MQ**&p_li=).

[99] Bill McFadden, "Details on FCC Wireless Mic License," March 9, 2001 (site visited on Jan. 23, 2005) (available at http://agora.rdrop.com/users/billmc/wireless_faq).

Similarly, ProSoundWeb.com, a self-described "web community for all aspects of the professional sound industry," which boasts 165,000 visitors per month, states on its web site:

> Despite some 'urban legends' to the contrary, all professional audio wireless microphones, wireless intercoms and wireless in-ear monitoring systems used in the U.S. are required to be licensed by the FCC…. Of course, *none of this seems sensible to most wireless system users, and the great majority simply ignore the requirement*. After all, it's only 50 mW! How far can that go? And many users are simply unaware of the FCC rules.[100]

Clearly, the Commission's Part 74 licensing requirement is not a priority for the wireless microphone community.

Despite the significant evidence of unauthorized wireless microphone operation, Shure suggests that new wireless devices be required to "sense" the presence of wireless microphones in the TV broadcast bands.[101] Intel opposes such a requirement as it would be impossible for a device to determine whether the microphone it "senses" is being operated by a legitimate licensee (who is entitled to secondary status in the TV broadcast bands) or by an unauthorized user (who is not entitled to any interference protection).[102] Moreover, as explained above, such "sensing" mechanisms in new wireless devices are unnecessary in order to avoid significant interference to Part 74 wireless microphones.[103]

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[100] Gary Stanfill, Principal Consultant, Colmar Systems, "The Bottom Line: Legal Use of Wireless Microphones," ProSoundWeb.com (emphasis added) (site visited on Jan. 23, 2005) (available at http://www.prosoundweb.com/install/commentary/garys/legalwireless.shtml).

[101] Shure Comments at ii, 20-23.

[102] If/when the Part 74 wireless microphone industry can assure the Commission that all wireless microphones using the TV broadcast bands are operated by properly licensed entities, Intel may revisit this position.

[103] *See supra* Section V. at 24-25 (discussing interference mitigation techniques available to wireless

In any event, the FCC's Part 15.244 proposal may render obsolete the operation of wireless microphones under Part 74.801. Indeed, wireless microphones could just as easily operate as Part 15.244 "personal/portable" devices. The proposed power level for Part 15.244 devices (*i.e.*, 100 mW)[104] exceeds the common power level for Part 74 wireless microphones (*i.e.*, 50 mW).[105] Moreover, Part 74.801 of the Commission's rules – which sets forth strict frequency deviation and bandwidth limits – discourages innovation in the wireless microphone arena, including wideband digital spread-spectrum modulation. On the other hand, the proposed Part 15.244 rules for "personal/portable" devices contain no such restrictions. For these reasons, Intel recommends that the FCC consider "grandfathering" Part 74 wireless microphone regulations and including them under Part 15.244. Such a migration of the Part 74 wireless microphone regulations to Part 15 would also align with the current deployment situation, where the lion's share of these devices are already operating in an unlicensed manner.[106]

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microphone operators).

[104] *Vacant TV Channels NPRM* at 28 (Appendix B: Proposed Rules).

[105] Shure Comments at 8.

[106] For example, "all types of musical and theatrical performances currently use wireless audio technology." Comments of the National Association of Music Merchants, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Sept. 7, 2004 at 2. However, most of these performances are not associated with video or motion picture production and, thus, are not eligible for Part 74 licenses. In fact, these wireless microphones are typically installed and used by musicians without professional spectrum coordination and without licenses.

VI. COMMENTERS AGREE THAT THE FCC HAS PROPOSED VARIOUS EFFECTIVE METHODS FOR AVOIDING HARMFUL INTERFERENCE TO LICENSED SERVICES

Commenters concur that the Commission has proposed a variety of effective methods for preventing harmful interference to authorized services in the TV broadcast bands. In particular, utilization of the "control signal" approach, the "sensing" approach, and the "professional installation/GPS" approach – depending on the type of new wireless device being operated – would effectively avoid harmful interference to licensed services in the TV broadcast spectrum.

A. UTILIZATION OF THE "CONTROL SIGNAL" APPROACH BY NEW WIRELESS DEVICES IS AN EFFECTIVE METHOD FOR AVOIDING HARMFUL INTERFERENCE

The FCC proposes to permit "personal/portable" devices to transmit only after receiving a "control signal" that positively identifies which TV broadcast channels are available for use.[107] NAB/MSTV incorrectly claim that "[u]se of a 'control signal' to determine whether an unlicensed device can safely operate on an 'unoccupied' television channel would be … unsuccessful."[108] This assertion is entirely inaccurate. It demonstrates a lack of understanding of "control signal" technology and fails to acknowledge the language and intent of the Commission's proposed rules.

Indeed, as noted in Comments submitted by Intel and other parties, the "control signal" method offers an effective way to prevent harmful interference from "personal/portable" devices sharing the TV broadcast bands.[109] NAB/MSTV's claim that

[107] *Vacant TV Channels NPRM* at 10.

[108] NAB/MSTV Comments at 14.

[109] Intel Comments at 14-15; Motorola Comments, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 8 ("Motorola Comments").

the "control signal" method would not work because "the unlicensed device may not 'hear' the correct signal" is false.[110] It directly ignores the language and intent of the FCC's proposed rules which plainly state: "The intentional radiator shall not operate if no unoccupied [channel] is available within its frequency range of operation or if it does not detect any unlicensed transmitters, FM or TV broadcast stations transmitting channel availability information."[111] Thus, the "control signal" approach is a highly reliable method for avoiding harmful interference to licensed users operating in the TV broadcast spectrum; if the "personal/portable" device does not "hear" a "control signal," the device simply will not operate.

Moreover, as Motorola illustrates, a best case propagation path can be calculated for a "control signal."[112] Since, in practice, the propagation path to a new wireless device will always be less than the theoretical best case, this assures that any such device receiving an appropriate "control signal," at a predefined level, will be well within a guaranteed physical location of safe operation.

B. UTILIZATION OF THE "SENSING" APPROACH BY "PERSONAL/ PORTABLE" DEVICES IS AN EFFECTIVE METHOD FOR AVOIDING HARMFUL INTERFERENCE

Another method for determining whether a portion of the TV broadcast spectrum is in use at a specific time and/or location is the "sensing" approach.[113] As Intel notes, the Commission has recognized that "[s]pectrum sensing may be appropriate in bands … where services may transmit for long periods of time, *e.g.*, broadcast type services, and

[110] NAB/MSTV Comments at 14.

[111] *Vacant TV Channels NPRM* at 28 (Appendix B: Proposed Rules).

[112] Motorola Comments at 8.

[113] *Vacant TV Channels NPRM* at 10.

sensing techniques would not need to be repeated frequently to be effective."[114] Intel and numerous other Commenters agree with the FCC and highly recommend the "sensing" approach – or a similar "cognitive" or "smart" technology approach – for avoiding harmful interference from "personal/portable" devices sharing the TV broadcast bands.[115]

Indeed, devices with "sensing" or cognitive radio technologies are able "to determine their location, sense spectrum use by neighboring devices, change frequency, adjust output power, and even alter transmission parameters and characteristics."[116] Moreover, as Intel's Comments discuss, there are multiple ways of "sensing," or identifying channel usage (*e.g.*, narrow band detection, FFT-based solutions).[117]

NAB/MSTV, however, incorrectly claim that "sensing" is an unproven technique and/or is not practical with respect to "personal/portable" devices.[118] For example, NAB/MSTV assert that "[t]he Commission should not introduce new uses of the television broadcast spectrum without actual proof … that such uses will preserve access to free, over-the-air television while producing other new, public interest benefits."[119] What NAB/MSTV fail to mention is that such proof already exists.

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[114] Intel Comments at 15 (citing *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, Notice of Proposed Rulemaking and Order, ET Docket No. 03-108, rel. Dec. 30, 2003, at 10 ("*Cognitive Radio NPRM and Order*")).

[115] *Id.* at 15-16.

[116] *Id.* at 16 (citing *Cognitive Radio NPRM and Order* at 2). *See also* Spectrum Policy Task Force Report at 14 (stating that cognitive radio devices can search the TV broadcast spectrum, sense the environment, and operate in spectrum not used by others).

[117] *Id.* at Appendix A at 1-2.

[118] NAB/MSTV Comments at 15.

[119] *Id.* at Comments at 24.

Indeed, companies such as Cognio, Inc. and Engim, Inc. are already offering products with spectrum "sensing" and signal identification functions in silicon devices.[120] Furthermore, multiple vendors such as Agilent Technologies, Anritsu Corporation, and Advantest Corporation are currently selling portable spectrum analyzers with similar detection capabilities.[121] In addition, as noted above, Shure's ULX Professional Systems product line boasts "Automatic Frequency Selection" technology that "provides a straight shot to a clear channel."[122] Thus, "sensing" technology is not only feasible, but it is already effectively in practice in various scenarios.

Moreover, the detection thresholds proposed by Intel are extremely conservative.[123] These thresholds will more than satisfy the requirements for reliable detection of TV broadcast stations, thereby precluding the possibility of inadvertent transmission on an occupied channel.

C. UTILIZATION OF THE "PROFESSIONAL INSTALLATION/GPS" APPROACH BY "FIXED/ACCESS" DEVICES IS AN EFFECTIVE METHOD FOR AVOIDING HARMFUL INTERFERENCE

The FCC proposes that "fixed/access" devices sharing the TV broadcast spectrum utilize the professional installation/GPS approach to avoid harmful interference to TV broadcast stations.[124] Specifically, the Commission proposes to allow new wireless

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[120] Cognio, Inc.'s silicon-based "sensing" solutions are CSP1000 and Spectrum Management ASIC. Engim, Inc.'s silicon-based "sensing" solutions are EN-3301, Tri-Channel Digital Baseband Processor, and MAC.

[121] Agilent Technologies' portable spectrum analyzer is E4402B. Anritsu Corporation's portable spectrum analyzer is MS2687B. Advantest Corporation's portable spectrum analyzer is R3271.

[122] *See supra* Section V. at 25 n.93 (citing Shure's ULX Wireless System Specification Sheet and User Guide).

[123] *See* Intel Comments at Appendix A at 5-6 (setting forth proposed detection thresholds).

[124] *Vacant TV Channels NPRM* at 13.

"fixed/access" devices to operate under the same technical provisions as digital transmission systems that operate under Section 15.247 of the FCC's rules.[125]

NAB/MSTV incorrectly assert that "use of GPS technology to identify the unlicensed device's location would not be sufficiently reliable to prevent interference to an occupied television channel … [because] … GPS receivers cannot function under many circumstances."[126] If this is the case, then NAB/MSTV need not worry; if the GPS receiver cannot function, then the new wireless device will not operate – obviating any potential interference threat.

Futhermore, the Commission's proposal to require "fixed/access" devices to automatically and periodically transmit a unique ID provides an additional measure of protection to licensed services.[127] Moreover, the automatic and periodic transmission of a unique ID could easily detect a potentially interfering device[128] – a measure of protection beyond that offered by other devices sharing the TV broadcast spectrum (*e.g.*, wireless microphones).

VII. ALLOWING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM WOULD ACCELERATE THE DTV TRANSITION – THEREBY BENEFITTING BROADCASTERS, CONSUMERS, AND TV SET MANUFACTURERS

NAB/MSTV suggest that the "fluidity" of the DTV transition is grounds for not allowing new wireless devices to operate in the TV broadcast spectrum. Quite to the

[125] *Id.* at 12; 47 C.F.R. § 15.247(b)(3) (providing rules regarding maximum peak output power for frequency hopping and direct sequence spread spectrum intentional radiators).

[126] NAB/MSTV Comments at 14.

[127] *Vacant TV Channels NPRM* at 12-13.

[128] Intel Comments at 19.

contrary, permitting new wireless devices to share the TV broadcast bands would provide a strong incentive to introduce new wireless communications devices and systems into the marketplace – including those capable of exploiting synergisms with TV broadcast services. The introduction of such devices would accelerate the DTV transition, thereby benefiting broadcasters, consumers, and TV set manufacturers.

A. THE FLUIDITY OF THE DTV TRANSITION IS NOT AN ANOMALY AMONG TECHNOLOGIES – AND IS NOT A RATIONAL REASON TO DELAY SHARING THE TV BROADCAST SPECTRUM

NAB/MSTV claim that the Commission should not adopt its proposal to allow new wireless devices to share the TV broadcast bands because "the transition to digital television … is at a … fluid point in its development."[129] This assertion is unconvincing as grounds for further delaying the sharing of the TV broadcast spectrum. Indeed, all technology, by its very nature, is fluid (*i.e.*, changing/adapting); DTV technology is not alone in this regard.

Moreover, the number of DTV transmitters is relatively small and the pace of DTV progress has been quite slow – vis-à-vis the large number of transmitters and the rapid pace of progress associated with other prevalent technologies. Accordingly, the DTV industry should not receive special treatment by the Commission.

For example, the cellular telephone industry utilizes many more transmitters and is significantly more dynamic than the DTV industry. Indeed, in the cellular telephone industry, millions of subscribers using millions of mobile radios are constantly changing

[129] NAB/MSTV Comments at ii. Notably, APTS, which filed separately from NAB/MSTV, suggests that, "should the Commission go forward with the authorization of such unlicensed devices, it should delay this action until the channel election process for final DTV channels has been completed." Comments of Association of Public Television Stations, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 1 ("APTS Comments"). Intel believes this may be a reasonable proposal, depending upon the duration of the channel election process.

locations, and millions of cell sites are regularly changing parameters in order to track and log users in databases on a real-time basis. By contrast, in the DTV industry, viewer locations/receivers are fixed and the small (in comparison) 1,600 broadcasters and thousands of broadcast towers hardly ever change parameters. Moreover, despite seven years of "hard work" by broadcasters, only "1,200 out of 1,600 [full-power] television stations … [have begun] broadcasting a digital signal."[130] Clearly, the rate of fluidity in the DTV industry is extremely slow relative to that of the cellular telephone industry (as well as numerous other technology industries) and, thus, is quite unpersuasive as a rationale for further delaying the sharing of the TV broadcast spectrum with new wireless devices.

B. PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST BANDS WOULD INCENTIVIZE MANUFACTURERS TO DEVELOP SYNERGISTIC PRODUCTS AND SERVICES

As Intel and other Commenters discuss, allowing wireless operation in the TV broadcast spectrum would provide a strong incentive to develop new wireless communications devices and systems[131] – including those capable of exploiting synergisms with TV broadcast services.[132] Indeed, "new unlicensed broadband operations may provide synergy with traditional broadcast operations and offer broadcasters the opportunity to provide new services."[133] For example, "APTS is interested in the possibility that … unlicensed devices … could work in tandem with the

[130] NAB/MSTV Comments at 5.

[131] *Vacant TV Channels NPRM* at 4.

[132] Intel Comments at 10; APTS Comments at 2; Comments of Consumer Electronics Association, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 7 ("CEA NOI Comments").

[133] *Vacant TV Channels NPRM* at 2.

broadcast service to provide additional 'back-channel,' thus enabling true two-way digital data services over-the-air."[134] APTS is further "encouraged by claims that … unlicensed devices with spectrum sensing technology could aid in the distribution of off-air DTV receivers in more consumer electronics equipment, such as personal computers, lap-tops, [and] PDAs."[135]

Moreover, allowing new wireless devices to share the TV broadcast bands would incentivize manufacturers to create complementary and ancillary products and services, which could very well accelerate the DTV transition.[136] As CEA has stated, "[i]f the Commission allows unlicensed use of vacant TV channels it could provide a win-win for broadcasters, TV [set] manufacturers, and new 700 MHz licensees by enabling and providing support for new service, including some which are complementary to DTV."[137] Certainly, "[t]here are innovative potential uses for unlicensed devices that could foster new functionalities for broadcast DTV" and "thereby likely accelerate the transition to DTV."[138]

As CEA has stated, "[c]onsumers, broadcasters, and [TV set] manufacturers all would benefit directly from th[is] increased functionality, and acceleration [of the DTV

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[134] APTS Comments at 2.

[135] *Id. See also* Comments of Community Broadcasters Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 4 (stating that "Class A and LPTV stations are interested in serving as beacons, using their vertical blanking interval in the analog mode and ancillary capacity in their digital signals").

[136] Intel Comments at 10; Comments of Wireless Internet Service Providers Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 11 ("WISPA Comments").

[137] CEA NOI Comments at 7.

[138] *Id.*

transition] would result in the 700 MHz spectrum (channels 52-69) becoming available to new licensees at an earlier date."[139] Indeed, "[e]xisting broadcasters will … find benefits as they explore more advanced television services"[140] – provided that they open up to the enormous possibilities.[141] Furthermore, consumers will benefit as increased competition among wireless broadband providers enables interactivity through a return path for broadcast stations or wireless video program home distribution.[142] TV set manufacturers will benefit as the industry develops new and innovative products capable of interfacing with DTV sets by utilizing the vacant TV broadcast channels. Thus, all parties would benefit as additional means of receiving DTV signals enter the marketplace.

VIII. THE PUBLIC INTEREST WEIGHS HEAVILY IN FAVOR OF PERMITTING NEW WIRELESS DEVICES TO SHARE THE TV BROADCAST SPECTRUM

This proceeding is not a "zero sum game," as NAB/MSTV would like the FCC to believe; in fact, broadcasters and wireless broadband services (as well as the public) can and should "win." Moreover, NAB/MSTV try to convince the Commission that it should not "risk" the DTV transition by allowing new wireless devices to operate in the TV broadcast bands because the benefits of such operation are "at best, speculative" and

[139] *Id.*

[140] Intel Comments at 10-11 (citing Statement of Michael K. Powell, Chairman, Federal Communications Commission, *Vacant TV Channels NPRM*).

[141] Intel believes that the failure of the broadcasting industry to more promptly embrace the "digital age" – as compared to the rapid progress in numerous other industries from consumer electronics to photography – reflects broadcasters' outdated mindset.

[142] CEA NOI Comments at 7.

"marginal."[143] This assertion not only is anachronistic and self-serving, but also it is simply not true – on all accounts. Indeed, as NAF points out, "the public interest weighs heavily in favor of permitting unlicensed access in the [TV] broadcast bands"[144] – as the public interest benefits created by such access would be substantial.[145]

A. THIS PROCEEDING IS NOT A "ZERO SUM GAME" – BOTH THE BROADCAST AND THE WIRELESS INDUSTRIES CAN AND SHOULD WIN

NAB/MSTV inappropriately contend that there is "a tension between two competing goals – the promotion of a successful transition to digital television and the opening up of spectrum below 1 GHz to unlicensed devices."[146] Framing the proceeding in this way is highly misleading.

In reality, this proceeding is not a "zero sum game" (*i.e.*, a choice between licensed DTV and new wireless broadband services),[147] as broadcasters would like the FCC to believe. Rather, the FCC initiated this proceeding because technological advances now enable licensed TV and new wireless services to co-exist successfully in the same bands, thus facilitating "more efficient and more effective use of the TV

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[143] NAB/MSTV Comments at ii, iii, 5.

[144] NAF Comments at 3.

[145] Intel Comments at 7; Microsoft Comments at 3-7; Comments of Telecommunications Industry Association, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at 5 ("TIA Comments"). *See also* NAF Comments at 1 (stating that "opening the broadcast bands to Part 15 [devices] will … produce a torrent of benefits").

[146] NAB/MSTV Comments at 3.

[147] *See* NAF Comments at 8 ("[N]othing in this proceeding requires the Commission to make a choice between the public interest value of free over-the-air television and public access to spectrum [for wireless broadband services]."); *id.* ("By opening the television broadcast bands to unlicensed access, the Commission will maintain the existing benefits of broadcast television and the conversion to digital while promoting the goals of the Communications Act and the First Amendment."); R. Paul Margie, "Can You Hear Me Now? Getting Better Reception from the FCC's Spectrum Policy," Stan. L. Rev. at 5, 6 (2004) (stating that the purpose of FCC spectrum regulation should be "to maximize total utility in each band rather than to minimize interference to any individual spectrum user").

spectrum."[148]

As the Commission points out, "there are technical options now available that make it feasible for new types of unlicensed equipment to share spectrum in the TV bands without causing harmful interference to TV broadcast [service]."[149] And, as discussed above – quite opposite to harming the DTV transition – allowing new wireless devices to share the TV broadcast spectrum could help accelerate the digital changeover.[150]

Thus, this proceeding can and should be a "win" for both the broadcast and the wireless industries, as well as the public. The only potential "loss" would be the failure to take advantage of technological innovations that enable more efficient and effective use of the TV broadcast spectrum.

B. THE PUBLIC INTEREST BENEFITS THAT WOULD BE GAINED FROM PERMITTING NEW WIRELESS DEVICES TO OPERATE IN THE TV BROADCAST SPECTRUM ARE FAR FROM "SPECULATIVE"

Contrary to what NAB/MSTV would like the Commission to believe, the public interest gains which would be generated by allowing new wireless devices to operate in the TV broadcast bands are far from "speculative."[151] History has shown that, when the FCC opens "new" spectrum to new wireless devices, market forces spur industry manufacturers and entrepreneurs to embrace the technology that is authorized to operate

[148] *Vacant TV Channels NPRM* at 2. *See also* TIA Comments at 3 ("[M]ore efficient spectrum access is essential for continued innovation in a wide variety products and applications … , including wireless broadband services.").

[149] *Vacant TV Channels NPRM* at 8.

[150] *See supra* Section VII. B. at 36 (discussing how allowing new wireless devices to share the TV broadcast bands would accelerate the DTV transition).

[151] *See contra* NAB/MSTV Comments at ii, 5 (claiming any gains would be "at best, speculative" and "marginal").

in the newly available spectrum – if viable and sound – thus causing that technology to grow exponentially.[152]

The increase in flexible wireless spectrum use over the last decade demonstrates the tremendous public interest gains that can be generated when the government enables market forces and consumer demand to determine new technology successes.[153] In short, the flexibility of spectrum use for new wireless solutions supports innovation and investment in new technologies. For example, as the Telecommunications Industry Association ("TIA") notes, the flexibility of spectrum use has enabled "wireless broadband platforms [to become] an increasingly popular alternative for … consumers to access the Internet."[154]

Indeed, "the rapid growth of WiFi – a WLAN technology – demonstrates the important role that unlicensed can play in the evolution of wireless services."[155] WiFi, which started as a 2 megabits per second ("Mbps") industry standard in 1997 (*i.e.*, just

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[152] Intel Comments at 11. *See also* "A Brief History of Wi-Fi," The Economist, at Technology Quarterly Sec. (June 12, 2004) ("Wi-Fi would certainly not exist without a decision taken in 1985 by the [FCC] … to open several bands of wireless spectrum … to communications entrepreneurs.").

[153] Most economists agree that reform should seek to increase the ability of market forces to shape how spectrum is used. NAF Brief at 7; s*ee also* Kenneth R. Carter *et al.*, "Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues," OSP Working Paper No. 39, at iv (May 2003) ("[E]ffective [spectrum] policy reform includes … promulgating rules to encourage technological and market-based solutions to optimize efficient use and spectrum sharing.").

In contrast to the market-driven approach, NAB/MSTV claim the FCC must define all specific uses of a technology before it can be introduced to consumers. NAB/MSTV Comments at 24, 29. Such archaic suggestions not only stifle market forces and consequently innovation, but also reflect unbridled self-interest in controlling the TV broadcast bands and a lack of understanding of the benefits of flexible spectrum use in the modern marketplace.

[154] TIA Comments at 3.

[155] NAF Brief at 2. *See also Vacant TV Channels NPRM* at 5 ("Part 15 unlicensed devices and wireless broadband services using such devices have been extremely successful … [over] [t]he past few years.").

seven years ago),[156] is now a 54 Mbps standard[157] – and is likely to become a 150 Mbps standard in the near future.[158] Moreover, "WiFi technology, unknown only a few years ago … now provides wireless Internet connections to about 28 million people in the [United States]."[159] In fact, as the Wi-Fi Alliance notes, "over the past few years, WiFi has … [become] a billion dollar industry."[160] Clearly, "[t]he expansion in [WiFi and other] wireless services is one of the most important trends that [has] transformed the Information, Communications and Technology (ICT) sector during the last decade."[161]

This enormous growth in the wireless marketplace will only intensify with the advent of WiMAX and other advanced wireless technologies in the near future.[162] Permitting new wireless devices to co-exist with existing licensed users in the TV broadcast spectrum would support this rapid technological innovation and industry transformation. Consequently, Intel believes that the Commission should promote more flexible spectrum use, as appropriate, in order to most effectively respond to modern

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[156] Coincidentally, 1997 was also the year that DTV technology was introduced. The dramatic success of WiFi (and the rapid *voluntary* inclusion of WiFi radios in PCs), in contrast to the paltry ramp of DTV (despite the *government mandated* inclusion of DTV tuners in new sets), is a stark indication of consumer preference and the value of flexible spectrum use. Moreover, the mere fact that NAB/MSTV claim that "the critical factor [in the DTV transition] is [now for the government] to create incentives for American consumers to turn off their analog television receivers and switch to … digital format" suggests that broadcasters themselves recognize the lack of consumer demand for DTV. NAB/MSTV Comments at 5. Consumer priorities clearly lie elsewhere, as reflected in the exponentially increasing purchases of wireless products and services.

[157] IEEE 802.11g is the 54 Mbps industry standard for WiFi.

[158] Intel notes that engineers are in the process of developing, IEEE 802.11n, a 150 Mbps standard for WiFi.

[159] Intel Comments at 4 (citing Spectrum Policy Task Force Report at 1).

[160] WFA Comments at 3.

[161] NAF Brief at 1. *See also* Intel Comments at 3-4 (discussing the relentless growth of, and demand for, wireless products and services).

[162] Intel Comments at 4.

market forces and consumer demand.

C. ALLOWING NEW WIRELESS DEVICES TO OPERATE IN THE TV BROADCAST BANDS WOULD CREATE SUBSTANTIAL PUBLIC INTEREST BENEFITS – ESPECIALLY IN RURAL AND UNDERSERVED AREAS

Contrary to what NAB/MSTV would like the Commission to believe, the public interest gains which would be generated by allowing new wireless devices to operate in the TV broadcast spectrum would be substantial.[163] President George W. Bush has set forth a goal of delivering broadband technology to every corner of the United States by 2007 – that is, within just two years.[164] As TIA notes, opening the TV broadcast spectrum to the operation of new wireless devices will go a very long way towards achieving this goal.[165]

Indeed, permitting new wireless devices to share the TV broadcast bands would significantly further the President's goal by stimulating more investment and competition in the broadband industry.[166] As the Commission states, this increased investment and competition "would [produce] significant benefits for the public by promot[ing] the development of new and innovative types of unlicensed broadband devices and services."[167] These developments, in turn, would lead to ubiquitously available and more

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[163] *Id.* at 7-12; Microsoft Comments at 3-7; TIA Comments at 5; NAF Comments at 1. *See contra* NAB/MSTV Comments at iii (claiming that any gains would be "marginal").

[164] Remarks of President George W. Bush, American Association of Community Colleges Annual Convention, Minneapolis, MN, Apr. 6, 2004 (available at http://www.whitehouse.gov/news/releases/2004/04/20040426-6.html).

[165] *See* TIA Comments at 3 ("[I]t is vitally important for the Commission to support wireless broadband in its policymaking efforts if it is to meet President Bush's stated goal of ensuring the availability of broadband technology in every corner of America by 2007.").

[166] Intel Comments at 8 n.31.

[167] *Vacant TV Channels NPRM* at 2.

affordable wireless broadband products and services throughout the country[168] – particularly in less densely populated areas where the greater distances between people have made it difficult thus far for certain types of wireless operations (*i.e.*, WISPs and wireless LANs) to provide adequate signal coverage.[169]

In fact, as numerous Commenters note, the highly favorable propagation characteristics of the TV broadcast bands would allow new wireless devices to serve applications requiring greater range of operation and signal coverage than that afforded to similar devices operating in higher frequency bands.[170] Indeed, Microsoft points out that "the potential coverage range for … [WISP signals] … dwarf the ranges typically achieved by unlicensed devices in the 2.4 GHz and 5 GHz bands."[171] As Intel and other Commenters note, the upshot for some rural and underserved areas is that opening the sub-1 GHz frequencies to wireless broadband use would likely make the difference between a high quality wireless broadband alternative and none at all.[172]

In addition to improving transmission, Commenters note that the ability to use TV broadcast frequencies would reduce the cost of providing wireless broadband services.[173]

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[168] Intel Comments at 8 (citing *Vacant TV Channels NPRM* at 5-6). *See also* Microsoft Comments at 5 ("Compared to spectrum currently available for WISPs, the advantages of using television spectrum are readily apparent.").

[169] Intel Comments at 8 (citing *Cognitive Radio NPRM* at 13); TIA Comments at 5; WISPA Comments at 15. *See also* NAF Comments at 3 ("Unlicensed access into the [TV] broadcast bands … will generally facilitate speedy deployment in those communities that traditionally must wait the longest for licensed services to deploy.").

[170] Intel Comments at 8 (citing *Vacant TV Channels NPRM* at 2, 4, 6 n.23, 7); TIA Comments at 4 -5; WFA Comments at 3; WISPA Comments at 2, 6; NAF Comments at v.; Comments of Information Technology Industry Council, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, April 7, 2003, at 4.

[171] Microsoft Comments at 6.

[172] Intel Comments at 8-9; Microsoft Comments at 1, 2, 7.

[173] Intel Comments at 9. *See also* WFA Comments at 3 ("[L]ess equipment operating at lower frequencies

For example, Intel estimates that, using 2.5 GHz frequencies would require four to five times as many base stations to achieve equal geographic coverage, for a given air interface and bandwidth.[174] Similarly, Microsoft states that "a WISP using spectrum below 1 GHz would need about 1/3 fewer base stations than, and about 50% of the capital investment of, a WISP using the 2.4 GHz or the 5 GHz bands."[175] As Intel and other Commenters note, the impact of these numbers is extremely significant, especially for rural and underserved areas where the allocation of TV broadcast frequencies for wireless use would dramatically accelerate broadband deployment.[176]

Like the President, the Commission recognizes the importance of providing wireless broadband access to rural and underserved areas.[177] Indeed, the FCC, in the first year of its "Lands of Opportunity: Building Rural Connectivity" outreach program, concluded that "[b]roadband has potential to serve as the *ultimate* economic, educational, and healthcare growth engine for the Nation – particularly in rural America."[178] In recent years, the Commission has become increasingly focused on providing wireless broadband

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… could equal lower infrastructure costs for … WISPs and others."); NAF Brief at 3 ("The electronics associated with operating at lower frequencies are less expensive.").

[174] Intel Comments at 9.

[175] Microsoft Comments at 6-7.

[176] Intel Comments at 9. *See also* Microsoft Comments at 6-7 ("The bottom line is that … these advantages … could make all the difference in providing cost-effective broadband to unserved and underserved areas of the country"); WFA Comments at 2 ("Access to TV band spectrum will speed broadband rollout."); WISPA Comments at 2 ("The impact of universal coverage on small, rural, economically deprived communities will be measurable."). In light of these substantial public interest benefits, NAB/MSTV's fear that "it would be unfair to consumers to allow unlicensed devices to operate in the television broadcast spectrum" is misplaced. *Contra* NAB/MSTV Comments at 21.

[177] *See* NAF Comments at 2-3 (noting that the Commission, "in numerous studies, reports, notices, orders, and speeches[,]" has recognized "the benefits expanded unlicensed access has brought to rural America").

[178] K. Dane Snowden, Chief, Consumer and Governmental Affairs Bureau, Federal Communications Commission, "Lands of Opportunity: Building Rural Connectivity," Presentation at FCC Open Meeting, July 8, 2004 (emphasis added).

service to such areas[179] – the most recent effort being the October 2004 launch of the "Rural Wireless Community VISION Program," a contest in which the FCC and the Rural Utilities Service will assist winning communities with wireless broadband deployment.[180] Clearly, the Commission sees the value of wireless broadband access to rural and underserved areas and understands the potential of broadband to deliver a vast array of content – including video streaming of broadcast programming – in an economical and convenient manner, regardless of where people live.[181]

[179] *See* Intel Comments at 9 -10 (noting the 2002 Spectrum Policy Task Force recommendation to improve rural spectrum access and the measures adopted by the FCC in 2003 to increase such access).

[180] "Wireless Bureau Announces VISION Program for Rural Broadband," *Telecom A.M.*, Warren Communications News, Vol. 10, No. 200, Oct. 18, 2004.

[181] In this regard, Intel notes that there is no service currently provided by TV broadcasters that could not be offered via wireless broadband service.

IX. CONCLUSION

For the reasons set forth above, Intel recommends that the Commission expeditiously modify its Part 15 rules to permit use of the TV broadcast bands by new wireless devices. At a minimum, the rule changes should enable wireless broadband operation in underutilized portions of the TV broadcast spectrum.

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APPENDIX A

CHANNEL AVAILABILITY ANAYSIS –

LOS ANGELES METROPOLITAN AREA

December 2004

Introduction/Summary

The National Association of Broadcasters ("NAB") and the Association for Maximum Service Television ("MSTV"), in jointly filed Comments, submit the results of a study which concludes that, in most large urban communities, there would not be any channels available for the operation of "fixed/access" devices at maximum power (*i.e.*, 4 watts) from antennas at 30 meters or more above ground level.[1]

In its Reply Comments (filed herewith), Intel explains why this conclusion is misleading. Not only does the NAB/MSTV study only addresses *high power* "fixed/access" devices operating at maximum possible power levels, it also completely fails to address the operation of *low power* "fixed/access" and "personal/portable" devices.

With respect to the latter, Intel points out that there would be a number of vacant channels available for the operation of low power "fixed/access" and "personal/portable" devices because the actual separation distances required for such operation are very modest (compared to the maximum power service analyzed in the NAB/MSTV study).

This Appendix documents Intel's findings with respect to the operation of low power devices in the Los Angeles area. Intel chose this location because the FCC's TV database indicates that the Los Angeles area has the highest concentration of TV broadcast stations in the country (*i.e.*, 40 analog, 34 digital, and 38 TV translator stations within a radius of 130 kilometers around central Los Angeles).

Intel's findings clearly show that a few channels are currently available for operation by low power "fixed/access" or "personal/portable" devices in the Los Angeles area. This number will only increase following the DTV transition (even taking into account the repacking of channels 52 to 69).

[1] Comments of the National Association of Broadcasters and the Association for Maximum Service Television, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at Exhibit A at 14-23.

Database Analysis

Intel examined the FCC's TV database as a starting point for its analysis. The database contains each TV broadcast station's call sign, channel number, license status, type of service, effective radiated power (ERP), antenna height, and location, as well as links to other relevant data (including each station's Grade A or B service area, as appropriate).

Intel conducted a preliminary analysis of the Los Angeles, New York City, San Francisco, and Chicago areas in order to find the location with the largest concentration of TV broadcast stations in the country.

Due to the greater heights of TV stations in the Los Angeles area, it has the largest service radius – 130 kilometers.[2] Intel determined that, of the other locations, New York has the next largest service radius – 100 kilometers.[3]

Thus, Intel concluded that Los Angeles has the most congested service area, followed by New York City. Table A1 (below) provides a detailed breakdown of TV broadcast stations by service type for these two areas.

Table A1. Types of TV Broadcast Stations in Los Angeles and New York City Areas

	Los Angeles (130 kms)		New York (100 kms)	
Type of Station	Number of Stations	Stations Channels 21-51	Number of Stations	Stations Channels 21-51
Full Service Analog	25	9	23	9
Class A Analog	3	3	2	1
Low Power	17	11	20	15
TV Translators	18	13	6	3
Boosters	3	1	2	0
Auxiliaries	1	0	0	0
Full Service Digital (In Service)	12	6	9	7
Full Service Digital (Under Construction)	8	7	2	1
Total	87	50	64	36

[2] *See* Figure A1.

[3] *See* Figure A2.

Coverage Analysis

Intel then performed a coverage analysis based on the Longley-Rice propagation model using the Radio Mobile Version 5.6.5 program from www.cplus.org.

Intel used the program to download the Shuttle Radar Terrain Map (SRTM) data applicable to the Los Angeles area.

Next, Intel sited the Los Angeles area TV stations at the geographic coordinates provided in FCC's TV database. Intel then made final adjustments to the coordinates in order to reflect the exact location and elevation for each station (as reported in each station's FCC license application).

Intel then ran the area coverage program in order to plot the Grade B signal level at the receiver input (-83dBm) when using a 10 db gain receive antenna at a height of 9 meters (30 feet) above ground. The transmit power, antenna height, and antenna pattern were set to the values provided in each station's filing.

Observations/Findings

The Longley-Rice predicted coverage areas for TV broadcast stations in the Los Angeles area are very different from the service contours provided in the FCC's database.[4] This incongruity is due to the fact Longley-Rice takes into account the actual intervening terrain along the propagation path, whereas the model used for the FCC filings is based on average terrain.

Although the difference between the Longley-Rice and FCC models is less noticeable in flatter parts of the country, the significant difference that occurs in highly irregular terrain (such as the terrain of the Los Angeles area) could lead to incorrect coverage expectations.

Thus, Intel believes that, in accordance with FCC policy, the Longley-Rice model should be used as a basis for predicting the actual coverage of TV broadcast stations *within and only within* the Grade B contour reported by the TV broadcast station.[5]

Intel found that the stations within the Los Angeles area could be divided into two categories based on their coverage:

(i) stations that provide almost total coverage of the area south-southwest of the San Bernardino mountains; and

(ii) stations that provide primary coverage northeast of the San Bernardino mountains.

Outdoor coverage by those stations to the south-southwest of the San Bernardino mountains was found to be largely independent of transmitter power. This is due to the high elevation of many of the transmitter sites and the almost line-of-sight propagation paths to outdoor antennas. Coverage to indoor antennas would obviously be more dependent on transmitter power.[6]

As Intel's Comments demonstrate, when the TV broadcast signal is at the level specified for the Grade B contour, the interference range of a low power device is less than 8 kilometers.[7] From the perspective of the low power device, a channel can therefore be

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[4] *See* Figure A3 (showing the maximum and minimum distant Grade B contours as filed for stations covering some or all of the primary coverage area in Los Angeles); Figure A4 (showing the Longley-Rice predicted contours for a high power channel in the Los Angeles area).

[5] Intel notes that most locations outside of the Grade B contour which are able to receive signals greater than those specified for the Grade B contour are located at high elevations that are difficult to access. Such locations are unlikely to be populated by new wireless devices.

[6] *See* Figure A4, Figures A6-A9 (providing examples of outdoor coverage).

[7] Comments of Intel Corporation, *In the Matter of Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* ET Docket Nos. 04-186, 02-380, Nov. 30, 2004, at Appendix at 6.

considered vacant if it is more than 8 kilometers outside of a station's Longley-Rice predicted coverage area.

From the perspective of a vacant TV broadcast channel, both the FCC model and the Longley-Rice model yield similar results when examining the heavily populated area south-southwest of the San Bernardino mountains. In this area, Intel found that there are a total of 14 vacant channels (VHF + UHF) throughout the entire area.[8] (This analysis was based on FCC filings for all stations in the area, including those under construction.) Within the channel block 21 to 51 – the block that several Commenters, including Intel, advocate for the operation of new wireless devices – there are two channels available.

Many of those stations currently operating are full service analog stations, analog TV translators, or analog LPTV stations that will cease to operate at the completion of the DTV transition.[9]

[8] *See* Table A2 ("Currently Vacant" column).

[9] *See* Table A2 (2nd column).

Table A2. Channel Allocations for the Los Angeles Area (130 kms radius)

Channel #	Current Allocation						Currently Vacant
2	NTSC						
3							Vacant
4	NTSC						
5	NTSC						
6							Vacant
7	NTSC						
8							Vacant
9	NTSC						
10							Vacant
11	NTSC						
12				TV Translator			Vacant
13	NTSC						
14					LM		
15				TV Translator			Vacant
16					LM		
17							Vacant
18	NTSC						
19				TV Translator			Vacant
20					LM		
21				TV Translator			Vacant
22	NTSC						
23			LPTV				
24	NTSC		LPTV			DTV	
25		Class A	LPTV	TV Translator			
26			LPTV	TV Translator		DTV	
27			LPTV	TV Translator			
28	NTSC						
29						DTV	
30	NTSC						
31				TV Translator		DTV	
32						DTV	
33			LPTV	TV Translator			
34	NTSC						
35						DTV	
36						DTV	
37	RA	RA	RA	RA	RA	RA	RA
38		Class A	LPTV			DTV	
39				TV Translator		DTV	
40	NTSC						
41				TV Translator		DTV	
42							
43				TV Translator		DTV	
44	NTSC						

Channel #	Current Allocation						Currently Vacant
45				TV Translator			
46	NTSC						
47				TV Translator			
48			LPTV	TV Translator			
49							
50	NTSC		LPTV				
51							Vacant
52	NTSC						
53						DTV	
54	NTSC			TV Translator			
55							Vacant
56	NTSC						
57	NTSC						
58	NTSC						
59			LPTV			DTV	
60						DTV	
61						DTV	
62	NTSC						
63	NTSC						
64	NTSC						
65						DTV	
66			LPTV			DTV	
67			LPTV				Vacant
68			LPTV				Vacant
69				TV Translator			Vacant
Totals	26	3	14	18	4	18	14

At the completion of the analog to digital transition, the analog TV broadcast channels will cease operation, thereby freeing up many more channels. While the repacking of channels 52 to 69 will result in the assignment of some of the vacated analog channels to digital channels (such that it is not possible to determine the exact number of vacant channels that will remain),[10] Intel fully expects that the number of vacant TV broadcast channels (and the amount of unused bandwidth) will increase after cessation of analog broadcasts and the repacking process.

[10] Intel notes that the repacking process allows for some choice by broadcasters as to whether they will retain their VHF channel or be assigned a UHF channel. *In the Matter of Second Periodic Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television*, Report and Order, MB Docket No. 03-15, rel. Sept. 7, 2004, at 14-30. Thus, it is not possible to determine precisely which channels will remain vacant after repacking is complete.

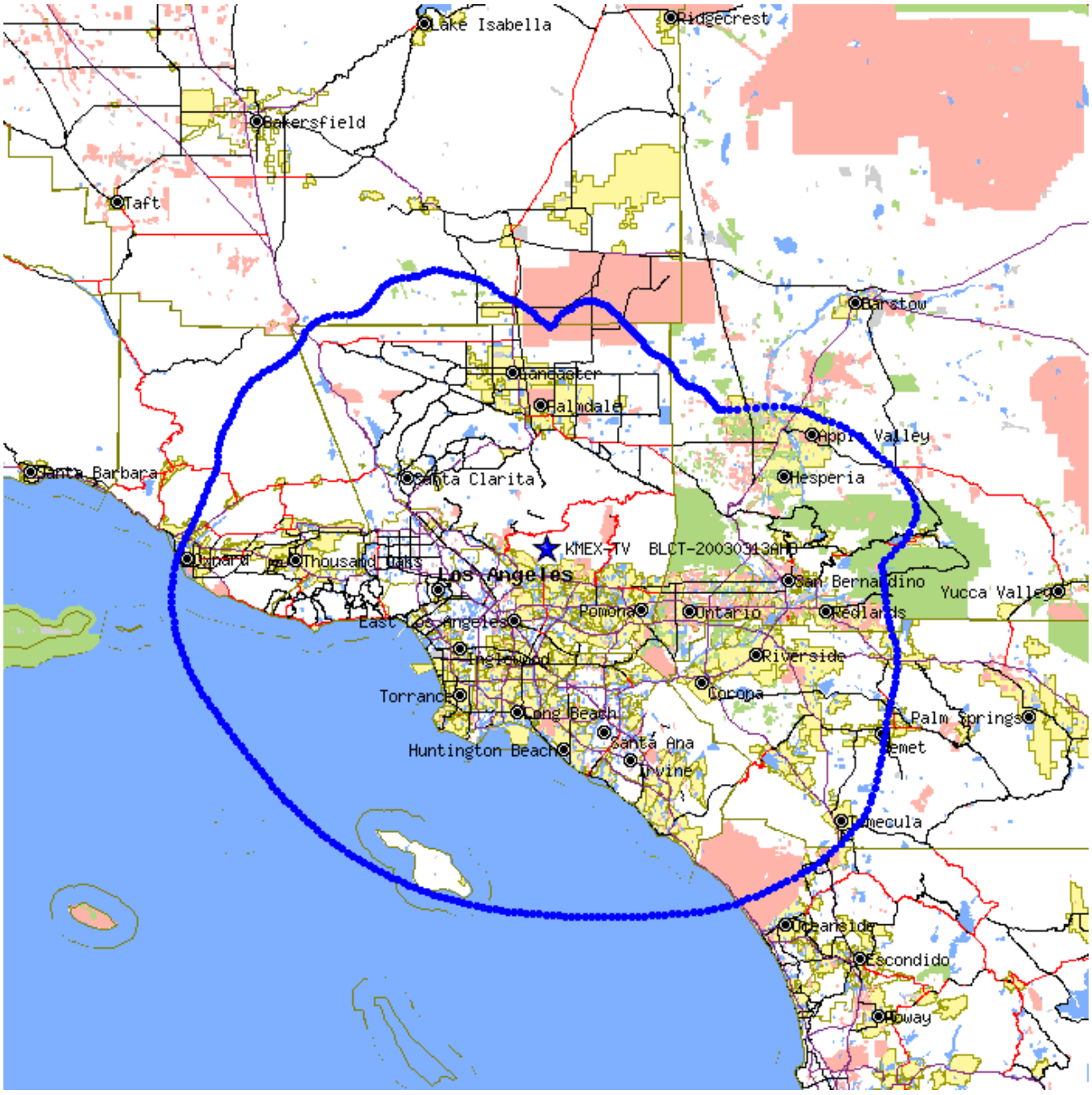

Figure A1. Maximum Grade B Contour as Filed for Los Angeles

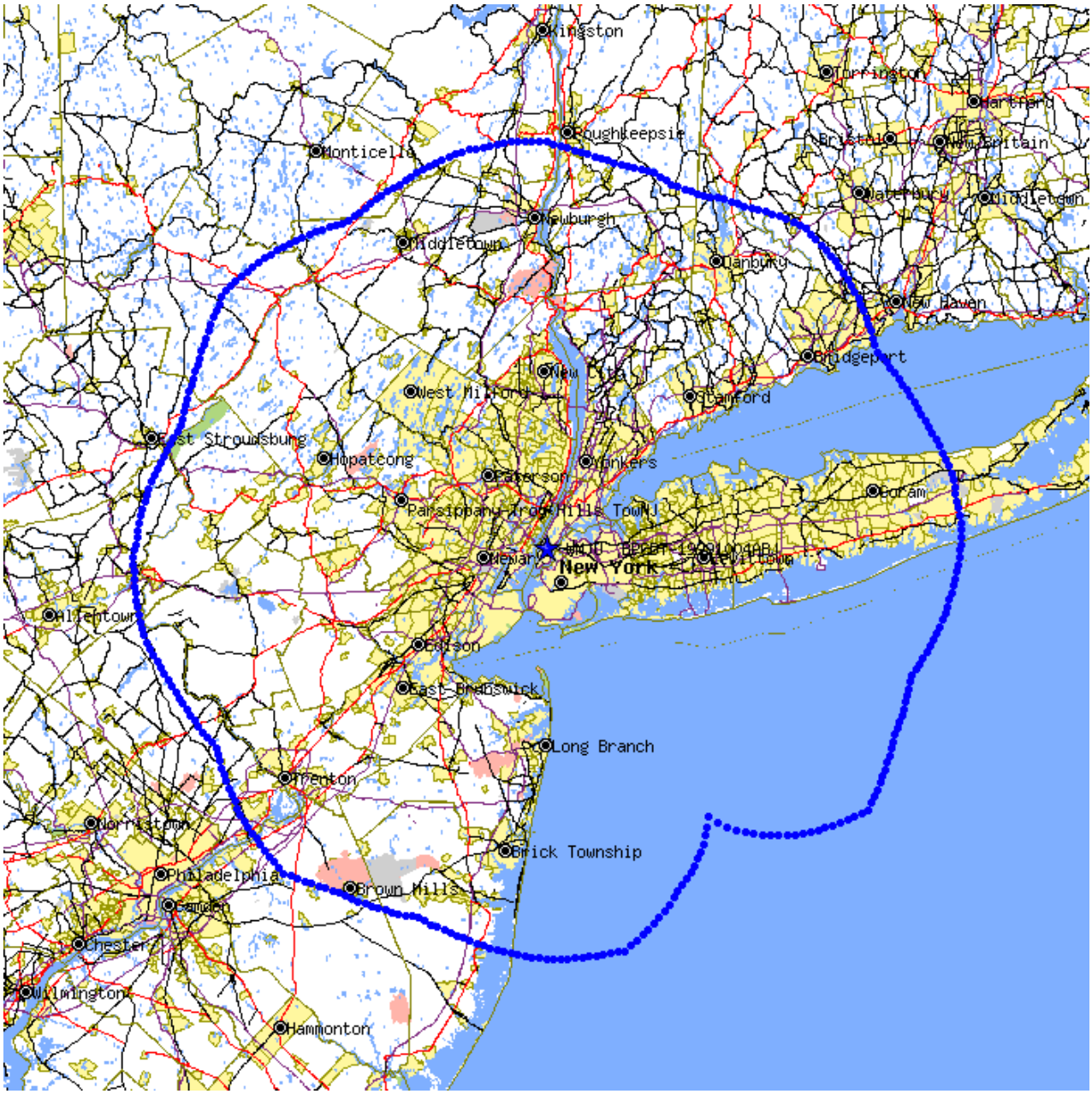

Figure A2. Maximum Grade B Contour as Filed for New York

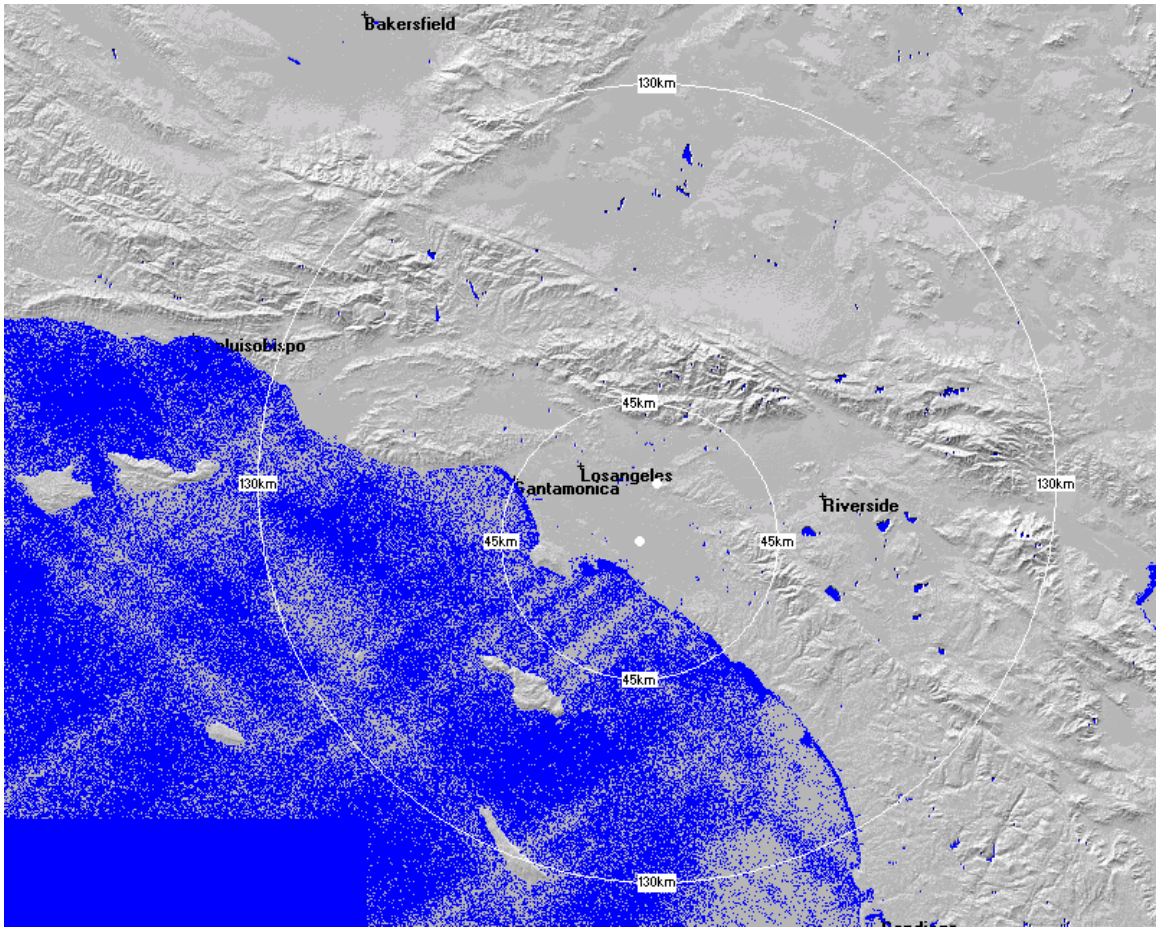

Figure A3. Approximate Maximum and Minimum Grade B Contours

(as filed for Los Angeles Area)

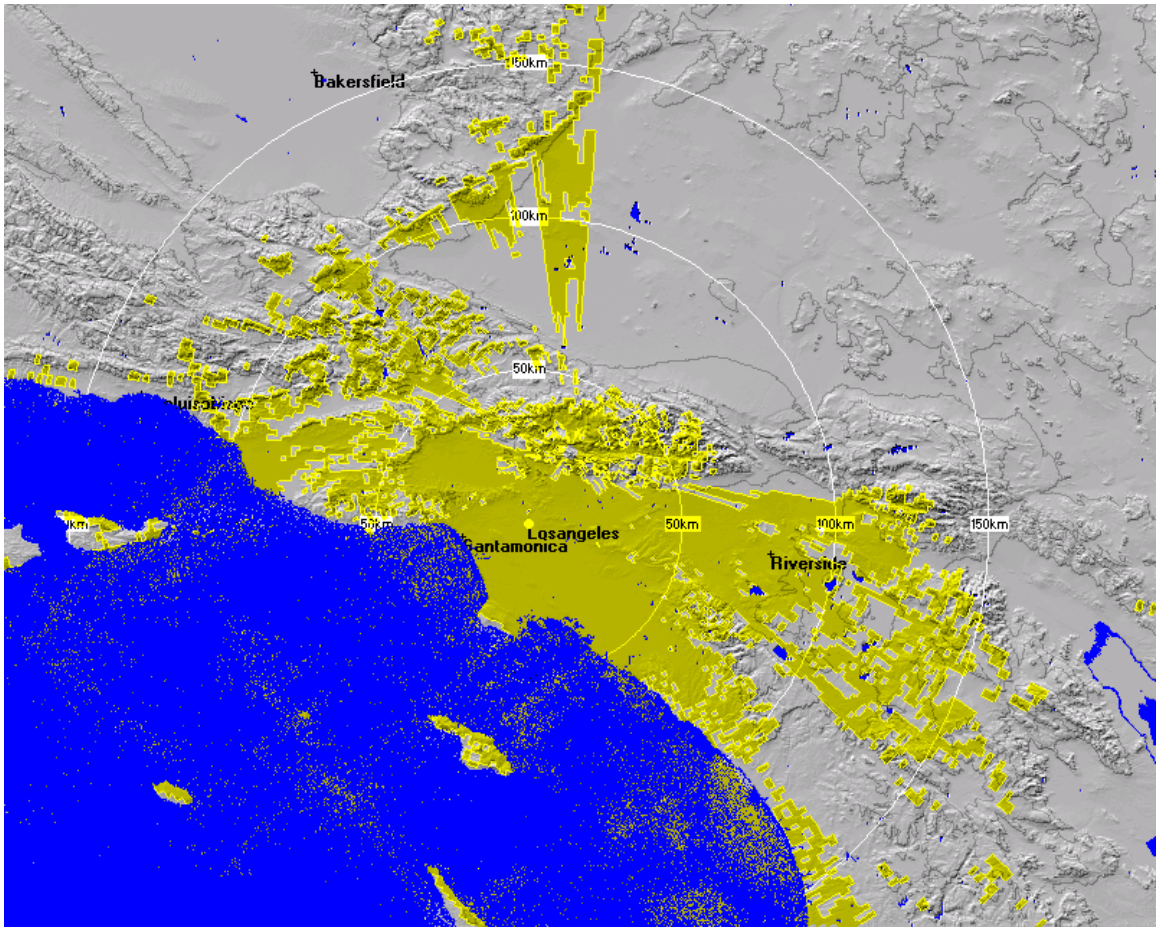

Figure A4. Longley-Rice Predictions for High Power Channel

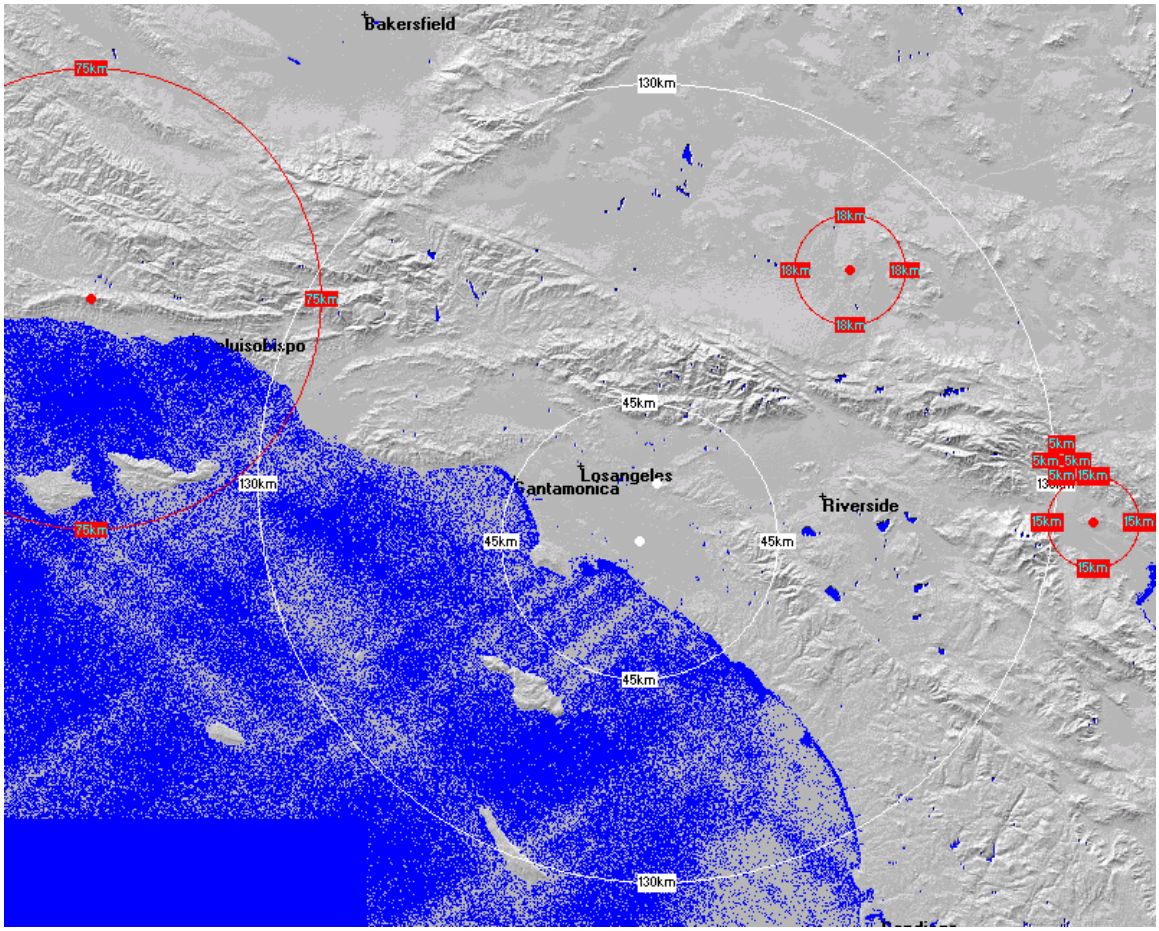

Figure A5. Channel 21 Grade B Filings

(Outside of the Primary Coverage of Los Angeles)

Note: This Figure illustrates that Channel 21 – a channel assigned within the greater Los Angeles area – can be vacant within the primary coverage area south-southwest of the San Bernardino mountains.

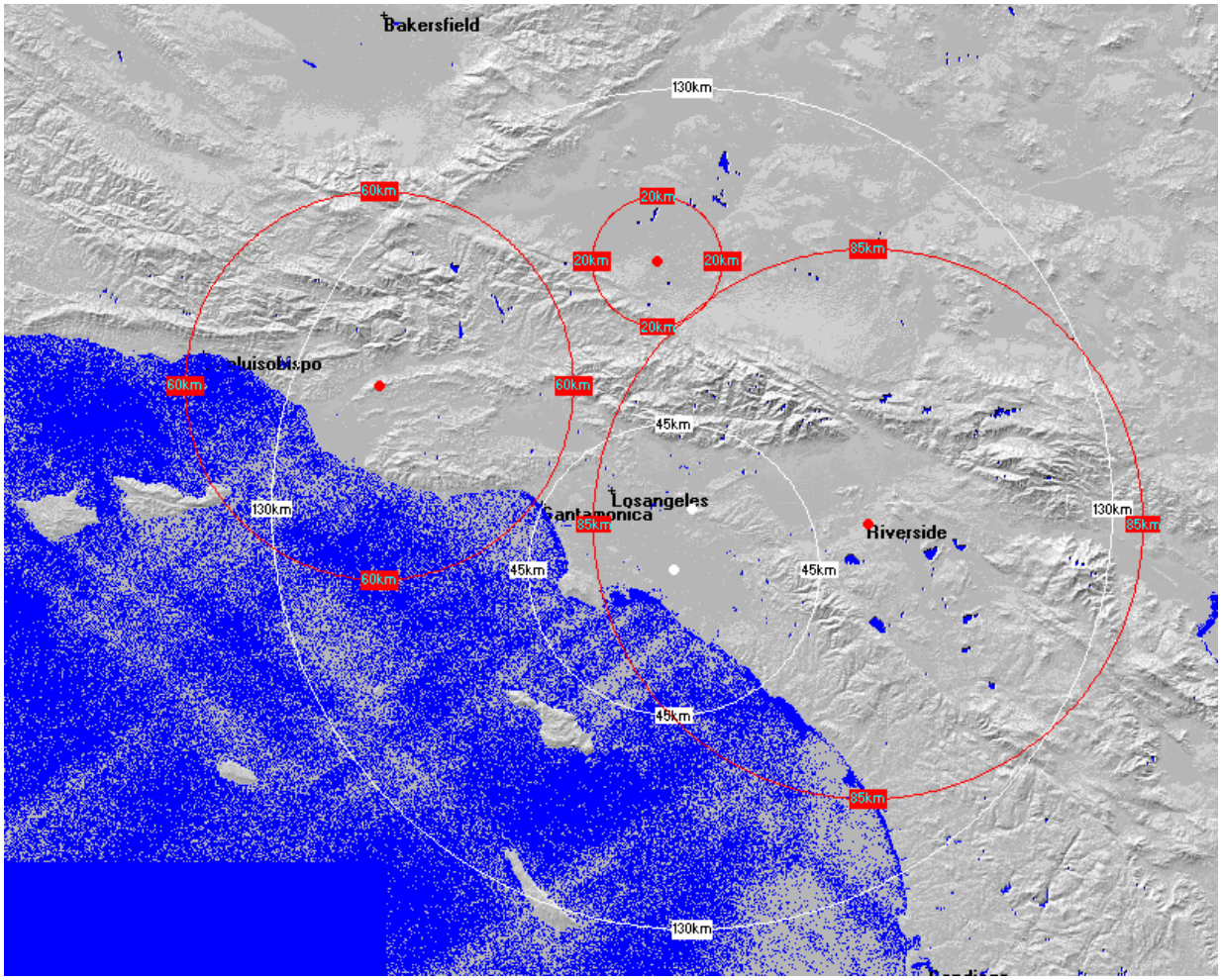

Figure A6. Channel 24 Grade B Filings

(White Space Outside of Primary Coverage Area)

Note: This Figure illustrates how channels used by LPTV stations assigned within the primary coverage area of channel 24 allow much "white space" both inside and outside of the primary coverage area of channel 24. As a result, in areas to the north of the San Bernardino mountains, a much larger set of channels is available.

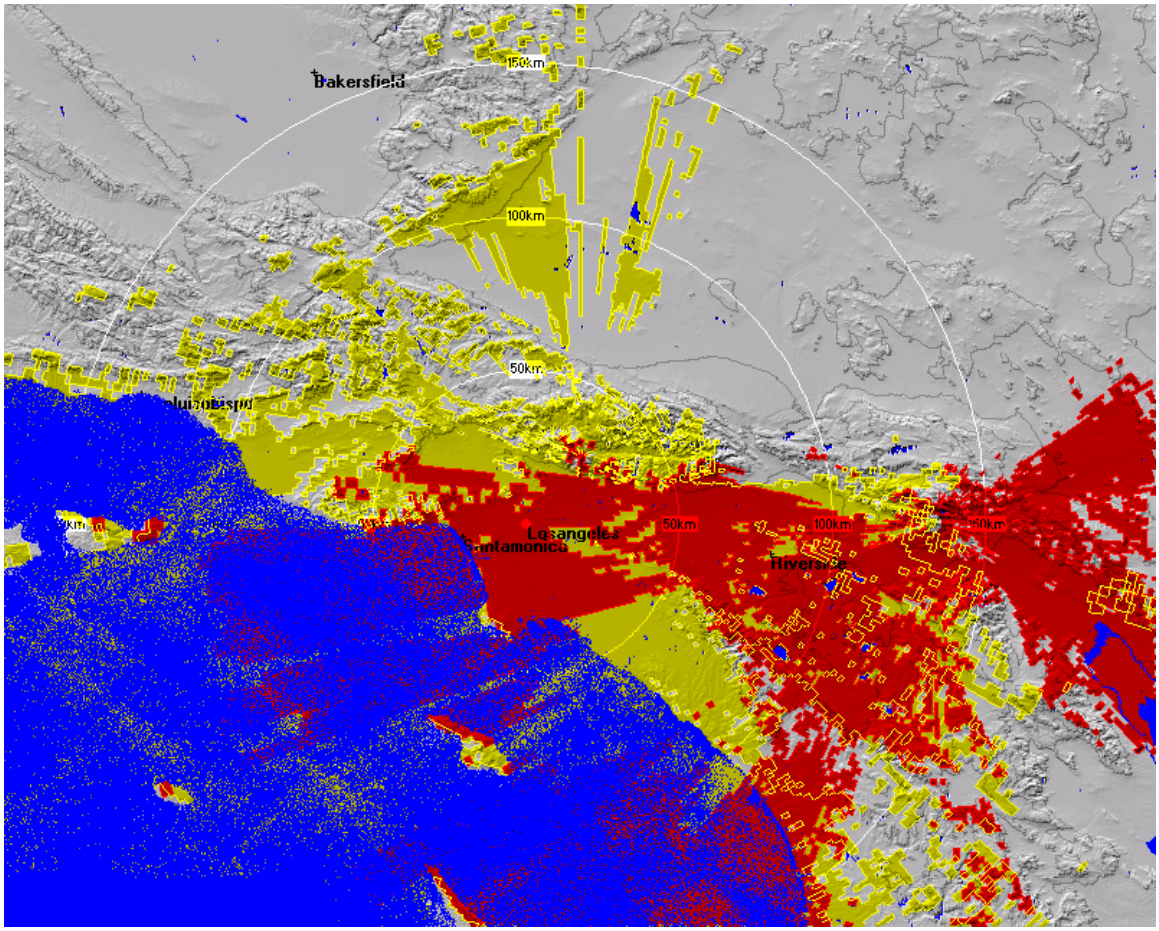

Figure A7. Channel 23 Longley-Rice Predictions

(Potential TV-to-TV Interference Within the Grade B Contour)

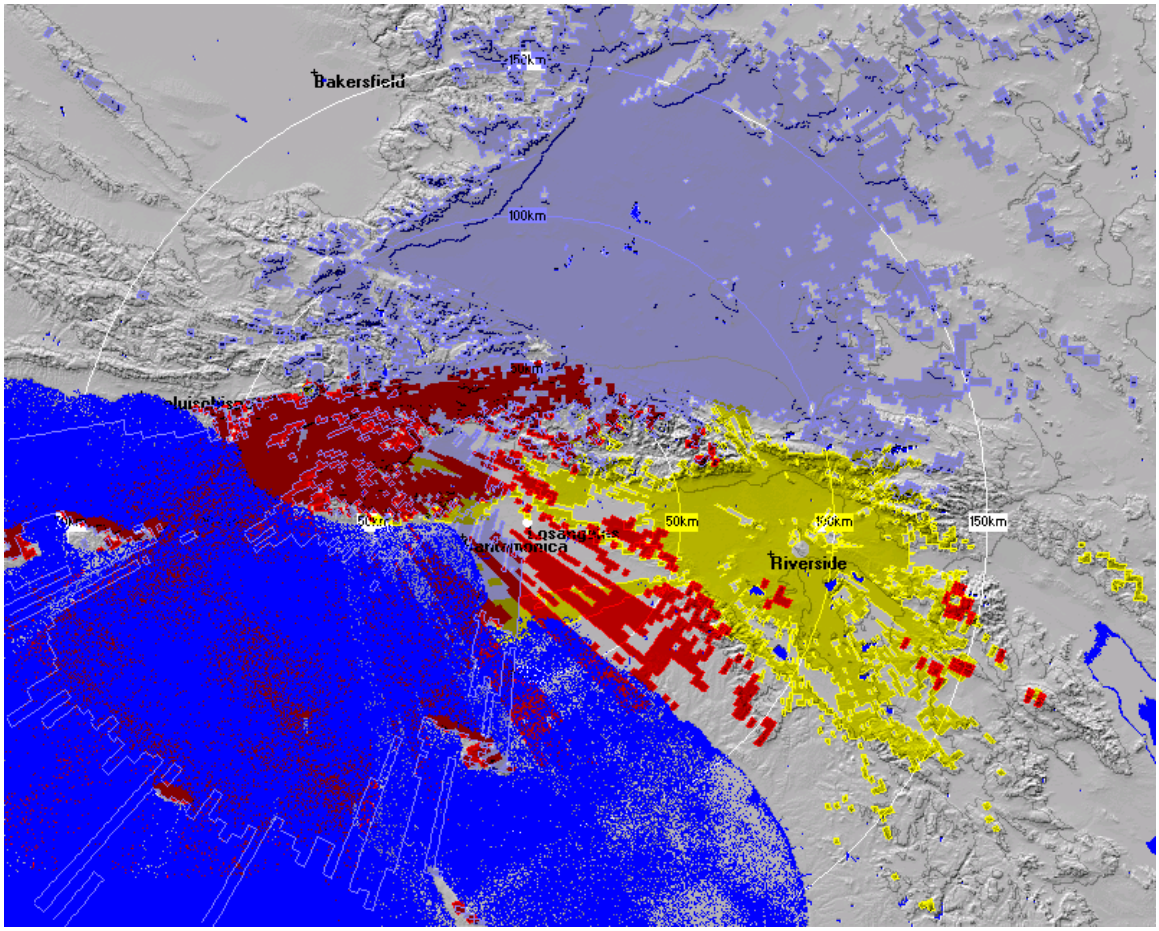

Figure A8. Channel 24 Longley-Rice Predictions

Note: This Figure illustrates that coverage to north of the mountains from the northern transmitter site greatly exceeds the Grade B filing for that site. However, low overlap with stations to the south of the mountains shows that channels can be reused.

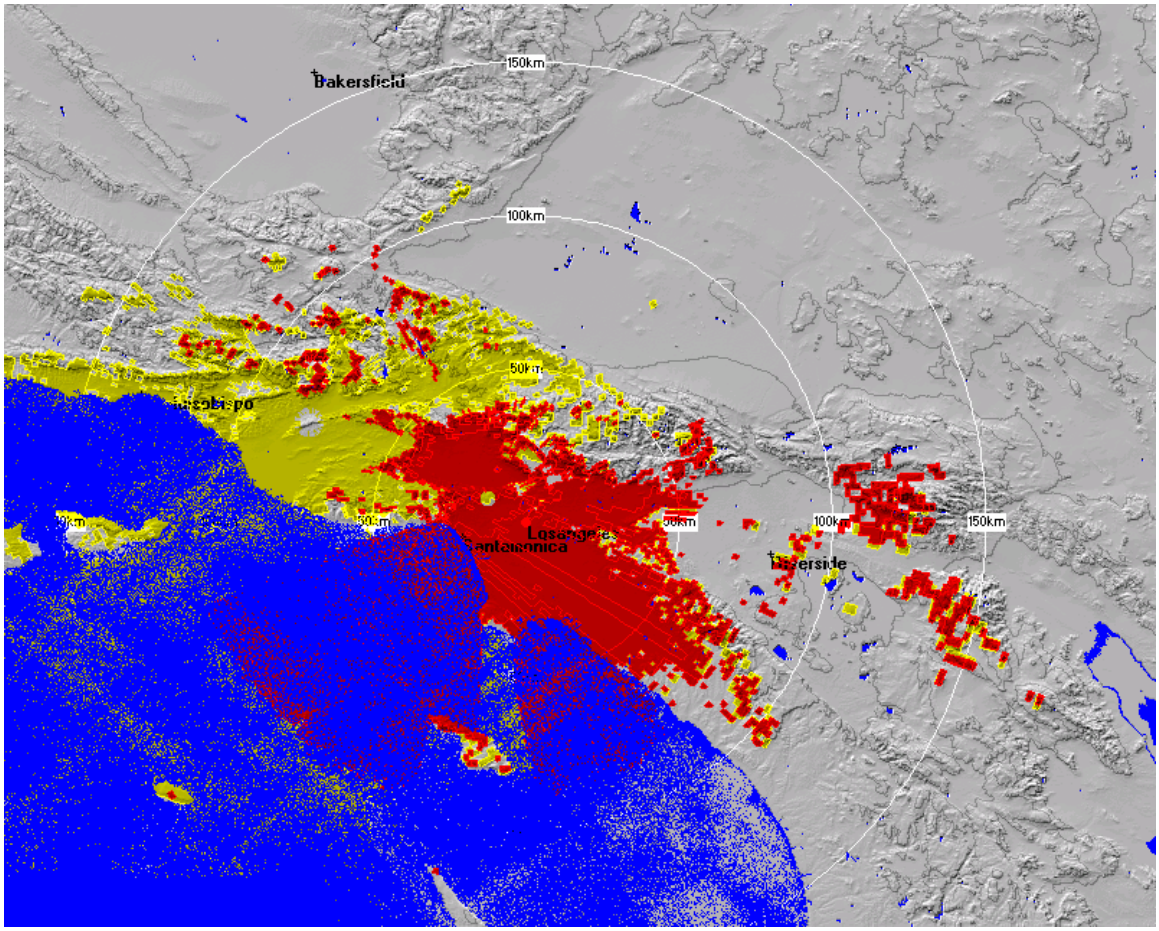

Figure A9 Channel 25 Longley-Rice Predictions

Note: This figure illustrates frequency reuse within the primary coverage area and in vacant space outside of the primary coverage area.

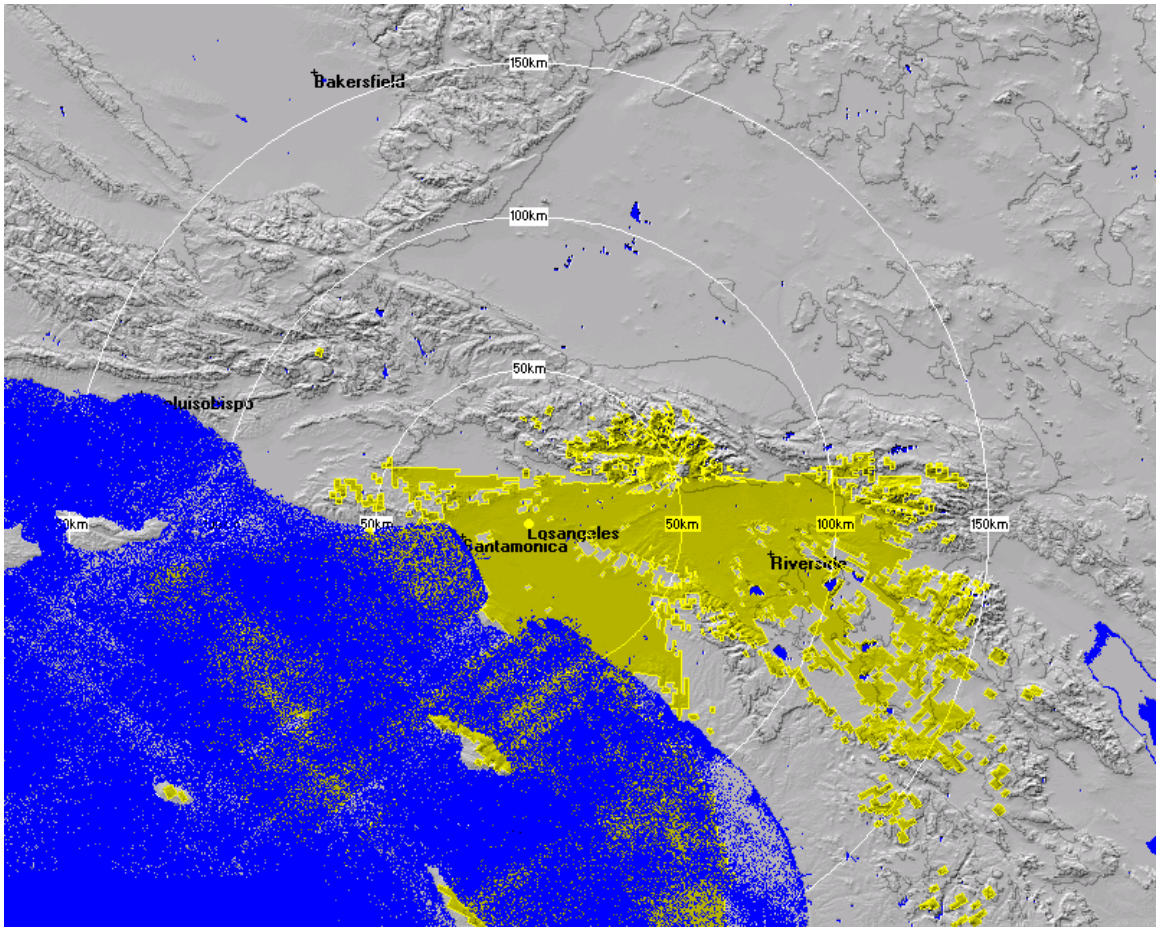

Figure A10. Channel 30 Longley-Rice Predictions

Note: This figure illustrates the existence of "white space" within the primary coverage area.